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Army Educational Outreach Program

College Qualified Leaders (CQL)

2017 Annual Program Evaluation Report

PART 2: Evaluation Findings

February 2018

aeop
ARMY EDUCATIONAL OUTREACH PROGRAM

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3 | Introduction

The Army Educational Outreach Program (AEOP) vision is to offer a collaborative and cohesive portfolio of Army sponsored science, technology, engineering and mathematics (STEM) programs that effectively engage, inspire, and attract the next generation of STEM talent through K-college programs and expose participants to Department of Defense (DoD) STEM careers. The consortium, formed by the Army Educational Outreach Program Cooperative Agreement (AEOP CA), supports the AEOP in this mission by engaging non-profit, industry, and academic partners with aligned interests, as well as a management structure that collectively markets the portfolio among members, leverages available resources, and provides expertise to ensure the programs provide the greatest return on investment in achieving the Army's STEM goals and objectives.

AEOP Priorities

Goal 1: STEM Literate Citizenry. Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.

Goal 2: STEM Savvy Educators. Support and empower educators with unique Army research and technology resources.

Goal 3: Sustainable Infrastructure. Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.

This report documents the evaluation study of one of the AEOP programs, College Qualified Leaders (CQL). In FY17 CQL was managed by the Academy of Applied Science (AAS). The evaluation study was performed by Purdue University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium.

Program Overview

The College Qualified Leaders (CQL) program, managed by the Academy of Applied Science (AAS), is an Army Educational Outreach Program (AEOP) that matches talented college students (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es). It should be noted that, while the objective is to pair each apprentice with an Army S&E. The use of the term "mentor" throughout this report will refer to the Army S&E working directly with student apprentices. This direct apprentice-mentor relationship provides apprentice training that is unparalleled at most colleges. CQL allows alumni of Gains in the Education of Mathematics and Science (GEMS) and/or Science and Engineering Apprentice Program (SEAP) to continue their relationships with mentors and/or laboratories, and also allows new college students to enter the program. CQL offers apprentices the opportunity for summer, partial year, or year-round research at Army laboratories, depending on class schedules and school location. CQL apprentices receive firsthand research experience and exposure to Army research laboratories. CQL fosters desire in

its participants to pursue further training and careers in STEM while specifically highlighting and encouraging careers in Army research.

In 2017, CQL was guided by the following objectives:

1. To nurture interest and provide STEM research experience for college students and recent graduates contemplating further studies;
2. To provide opportunities for continued association with the DoD laboratories and STEM enrichment for previous SEAP, GEMS, and other AEOP participants as well as allow new college students the opportunity to engage with DoD laboratories;
3. To outreach to participants inclusive of youth from groups historically underrepresented and underserved in STEM;
4. To increase participant knowledge in targeted STEM areas and develop their research and laboratory skills as evidenced by mentor evaluation and the completion of a presentation of research;
5. To educate participants about careers in STEM fields with a particular focus on STEM careers in DoD laboratories;
6. To acquaint participants with the activities of DoD laboratories in a way that encourages a positive image and supportive attitude towards our defense community; and
7. To provide information to participants about opportunities for STEM enrichment and ways they can mentor younger STEM students through GEMS, eCYBERMISSION, and other AEOP opportunities.

Twelve Army labs hosted CQL apprentices in FY17 (see Table 1). The 12 host sites received applications from more potential apprentices than they had positions for in 2017: 997 applications were received from 565 students (some applied to more than one site) and 229 students who were enrolled in CQL. This represents a 14% increase in applications (a 17% increase in number of applicants) and a 3% decrease in the number of enrolled participants compared to 2016 when 861 applications were received from 467 students and 236 apprentices who were enrolled. Table 2 summarizes applicants and final enrollment by site.

Table 1. 2017 CQL Sites		
2017 CQL Site	**Command**[†]	**Location**
U.S. Army Research Laboratory – Aberdeen Proving Ground (ARL-APG)	RDECOM	Aberdeen, MD
U.S. Army Research Laboratory – Adelphi (ARL-A)	RDECOM	Adelphi, MD
Walter Reed Army Institute of Research (WRAIR)	MRMC	Silver Spring, MD
U.S. Army Medical Research Institute for Infectious Diseases (USAMRIID)	MRMC	Fort Detrick, MD
U.S. Army Aviation & Missile Research Development and Engineering Center – Redstone Arsenal (AMRDEC)	RDECOM	Huntsville, AL
U.S. Army Engineer Research & Development Center Construction Engineering Research Laboratory (ERDC-CERL)	USACE	Champaign, IL
U.S. Army Center for Environmental Health Research (USACEHR)	MRMC	Fort Detrick, MD
Defense Forensic Science Center (DFSC)	USACIDC	Forest Park, GA
U.S. Army Edgewood Chemical Biological Center – Aberdeen Proving Ground (ECBC-APG)	RDECOM	Aberdeen, MD
U.S. Army Edgewood Chemical Biological Center – Rock Island (ECBC-RI)	RDECOM	Rock Island, IL
U.S. Army Engineer Research & Development Center – Vicksburg, MS (ERDC-MS)	USACE	Vicksburg, MS
U.S. Army Engineer Research & Development Center – Alexandria, VA (ERDC-GRL)	USACE	Alexandria, VA

[†] Commands: "MRMC" is the U.S. Army Medical Research and Materiel Command, "RDECOM" is the U.S. Army Research, Development and Engineering Command, and "USACE" is the U.S. Army Corps of Engineers

Table 2. CQL Applicant and Participant Data		
2017 CQL Site	**FY2017**	
	No. of Applicants	**No. of Enrolled Participants**
U.S. Army Research Laboratory (ARL-APG) – Aberdeen Proving Ground, MD	155	42
U.S. Army Research Laboratory (ARL-A) – Adelphi, MD	133	40
Walter Reed Army Institute of Research (WRAIR) – Silver Spring, MD	153	46
U.S. Army Medical Research Institute for Infectious Diseases (USAMRIID) – Ft. Detrick, MD	106	18
U.S. Army Aviation & Missile Research Development and Engineering Center (AMRDEC) – Redstone Arsenal, AL	85	18
U.S. Army Edgewood Chemical Biological Center (ECBC-APG) – Aberdeen Proving Ground/Edgewood, MD	78	14
U.S. Army Edgewood Chemical Biological Center (ECBC-RI) – Rock Island, IL	21	4
U.S. Army Engineer Research & Development Center Construction Engineering Research Laboratory (ERDC-CERL) – Champaign, IL	31	8
U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) – Aberdeen Proving Ground/Edgewood, MD	7	0
U.S. Army Center for Environmental Health Research (USACEHR) – Fort Detrick, MD	69	13
Defense Forensic Science Center (DFSC) – Forest Park, GA	55	10
U.S. Army Engineer Research and Development Center (ERDC-MS) – Vicksburg, MS	48	14
U.S. Army Engineer Research & Development Center (ERDC-GRL) – Alexandria, VA	56	2
Total	**997**	**229**

[††] ARL-West was not marketed as a CQL location in FY17; the program is currently working with this site to add it to the apprentice programs.

Table 3 provides demographic profiles for participating apprentices. Over half of 2017 CQL participants were female (54%), a slight increase as compared to 2016 when 46% were female. About two-thirds (67%) were White (65% in 2016). A somewhat smaller proportion of 2017 participants identified themselves as Black or African American as compared to 2016 participants (7% in 2017; 11% in 2016). Over a fifth of

participants (22%) fell into the category of "underserved" using the AEOP definition of underserved students.[1]

Table 3. 2017 CQL Apprentice Participant Profile		
Demographic Category		
Participant Gender (n = 229)		
Female	123	54%
Male	106	46%
Not Reported	0	0%
Respondent Race/Ethnicity (n = 229)		
Asian	31	14%
Black or African American	17	7%
Hispanic or Latino	12	5%
Native American or Alaska Native	0	0%
White	153	67%
Other race or ethnicity	10	4%
Choose not to report	4	2%
Underserved (n =229)		
Yes	51	22%
No	178	78%
Choose not to Report	0	0%

The total cost of the 2017 CQL program was $1,874,600. This includes administrative costs to AAS of $120,154 and $1,745,018 for participant stipends. The average cost per 2017 CQL participant taken across all CQL sites was $8,186. Table 4 summarizes these program costs.

[1] AEOP's definition of underserved includes at least two of the following: low-income students; students belonging to race and ethnic minorities that are historically underrepresented in STEM; students with disabilities; students with English as a second language; first-generation college students; students in rural, frontier, or other Federal targeted outreach schools; females in certain STEM field.

Table 4. 2017 CQL Program Costs	
2017 CQL - Cost Per Participant	
Total Student Participants	229
Total Program Cost	$1,874,600
Cost Per Participant	$ 8,186
Administrative Cost to AAS	$120,154
Participant Stipends	$1,745,018
Other costs	$9,428

4 | Evidence-Based Program Change

All AEOP apprenticeship programs are administered by the Academy of Applied Science and are combined into an overall apprenticeship portfolio. Objectives and activities for the apprenticeship programs were developed and implemented collectively for all programs and included the following:

1. Expand apprenticeship opportunities for underserved populations in cooperation with HBCUs/MSIs and other affinity groups, and in cooperation with recruitment objectives of LPCs by disseminating program information to a broader and more diverse audience. (Supports Priority 1)

- Distributed program information to various organizations to increase diverse audience:
    - Published apprenticeship opportunities to high schools and universities located near Army labs and universities using direct mail and email campaigns.
    - Expanded outreach efforts to include superintendents of Title I high schools close to universities and DoD laboratories.
    - Received high school and community outreach assistance from The SEED School of Maryland, Center for Excellence in Education in McLean, Virginia, Iowa Education Services Officer (National Guard) and Educational Services Specialist (Army) in New Jersey.
    - Approximately 300 universities posted apprenticeship opportunities on career assistance pages.
    - University host directors distributed flyers to college students to promote URAP and CQL, as well as mentorship.
- Improved program awareness and mentor participation by:
    - Sending mentors certificates of appreciation and letters of appreciation, as well as sending letters to the university deans, as appropriate.
    - Working with Widmeyer and Metriks to profile mentors (and students) in AEOP blogs and Alumni Spotlights – 10 in FY17 with 7 more apprenticeship spotlights in development. It is anticipated that mentor blogs and spotlights will spark interest in future program participation.
    - Since last year's ongoing summer communication was successful, continued this effort in FY17, sending student and mentor information on the following topics:
        - STEM Career links and FY17 STEM Career flyer
        - DoD STEM Webinar
        - Other AEOP programs
        - AEOP Travel Award
        - 21st Century Skill Assessment Pilot Program
        - Program Evaluation
        - Poster tips

2. Expand cross-marketing and outreach of apprenticeship programs to include other AEOP programs to mentors and LPCs. (Supports Priority 1 & 3)

- Published AEOP program and DoD opportunities to directors/mentors and students through email throughout the summer such as, DoD STEM Webinar information, STEM Career links and the FY17 STEM Career flyer.
- Assisted CAM office to implement a new STEM Career Opportunity Webinar; encouraged mentors and students to participate.
- All directors/mentors, students and lab coordinators received AEOP brochures/rack cards, AEOP notebooks, flash drives and pens. In addition, students received lab coats to promote all AEOP programs.
- Continued with social media campaign, including AAS Instagram account and hashtag campaign to engage participants.
- Cross marketing by sharing posts about all AEOP programs.
- Participated on marketing committee to share program content and cross promote AEOP.
- Supplied news stories and photos to Widmeyer and assisted with AEOP blogs and Alumni spotlights
- AEOP program information and outreach was done at the following events/site locations in FY17:
    - Massachusetts STEM Summit
    - The SEED School of Maryland
    - Vermont Tech Jam
    - NSTA conference
    - eCYBERMISSION 9th grade students
    - Young Inventors' Program Regional Invention Convention
    - All JSHS Regions
    - NC A&T University - 4 sites
    - City University of NY - 2 sites
    - Fayetteville State University
    - Duke University
    - University of Houston
    - University of Houston, Downtown
    - UNC Charlotte

3. Encourage apprentices to continue pursuit of AEOP STEM/Army STEM careers (Supports Priority 1)

- Worked with CAM office to develop and publicize DoD STEM Career webinars for all apprenticeships showcasing Army scientists and engineers.
- Students learned about Army STEM careers through direct engagement with Army scientists and engineers in DoD laboratories.
- Worked with Widmeyer and Metriks to profile mentors in universities and DoD laboratories to showcase STEM careers in AEOP blogs and Alumni Spotlights.
- Since last year's ongoing summer communication was successful, continued this effort in FY17, sending student and mentor information on the following topics:
    - STEM Career links and FY17 STEM Career flyer
    - DoD STEM Webinar

- Alumni Survey Link
- Other AEOP programs
- AEOP Travel Award
- 21st Century Skill Assessment Pilot Program
- Program Evaluation
- Poster tips

4. Encourage more students already in the AEOP pipeline to continue with an apprenticeship program by utilizing Alumni and CVENT databases to collect past participant information in order to send out alert emails of program application openings. (Supports Priority 1 & 3)

- Worked with Metriks to secure Alumni information. Apprenticeship announcement flyers were sent to over 3,000 alumni from the GEMS, UNITE, JSS, SEAP, HSAP, REAP, JSHS.
- Distributed alumni survey link to directors, mentors and students.
- Distributed Alumni Spotlight to current participants to showcase other programs.
- Worked with partners (eCYBERMISSION, UNITE and JSHS) to distribute program information to cross promote.
- Reviewed and provided feedback to Widmeyer regarding updates to the AEOP website.
- 26% of student participants in apprentice programs participated in GEMS or SEAP. However, it is important to note that 243 students (or 42%) participated in at least one other AEOP program.

5. Increase participant's knowledge of other AEOP programs and STEM careers (Supports Priority 1)

- Apprenticeship flyers were distributed to high schools, alumni and after school programs located near underserved communities close to universities and DoD laboratories. Emails also included a link to the AEOP website outlining other AEOP opportunities.
- Welcome packets were distributed to participants comprised of: Lab coats, flash drives, notebooks, pens/pencils, AEOP brochures/rack cards and all AEOP program opportunities.
- Weekly communication to participants highlighted all AEOP programs and AEOP 2017 STEM Career Guide, AEOP blogs, AEOP social media info about other AEOP opportunities.
- Visited WRAIR and spoke with mentors and apprentices about the student experience in a DoD laboratory, their research project, and their overall apprenticeship experience. Students indicated that this experience has increased their STEM knowledge and affirmed their choice to continue in a STEM related field in the future.
- Worked with CAM office to develop and publicize DoD STEM Career webinars for all apprenticeships showcasing Army scientists and engineers.
- Worked with Widmeyer and Metriks to profile mentors (and students) in AEOP blogs and Alumni Spotlights.

6. Improve the overall participant and mentor apprenticeship experience. (Supports Priority 1 & 3)

- Worked with university directors/mentors to develop best practices.

- Developed and distributed poster guidelines to students and mentors.
- Assisted mentors with the 21st Century Pilot Program Evaluations.
- Developed student orientation & welcome document.
- Worked with the CAM office to research, develop, and present the DoD STEM Career webinar series to showcase Army scientists and engineers.
- Instituted a new stipend policy to ensure prompt stipend processing.
- Regular communication with students and mentors regarding program outcomes and expectations.
- Applications opened earlier, and in some cases, closed earlier to allow for more time to complete security clearance and issuing of CAC cards at DoD laboratories. One of the primary goals of an earlier close date was to implement the notification process for selected and non-selected participants so that students would have time to apply to other summer STEM opportunities.
- The Mentor Toolkit provided valuable ideas for assisting mentors. The Toolkit suggested ideas to develop an ongoing conversation with mentors about how to assist students in research and life skills, develop best practices in mentoring, and security issues. The Toolkit is a resource for IPA's and LC's to use in helping mentors.
- Distributed AEOP travel award information to participations. Twelve (12) apprenticeship participants were awarded in FY17.
- Assisted mentors with the 21st Century Pilot Program Evaluations.
- Developed student orientation & welcome document.
- Worked with the Army to research, develop, and present the DoD STEM Career webinar series to showcase Army scientists and engineers.
- Instituted a new stipend policy to ensure prompt stipend processing.
- Regular communication with students and mentors regarding program outcomes and expectations.
- Disseminated information about the AEOP Travel Award and received several interests.

5 | Evaluation At-A-Glance

Purdue University, in collaboration with AAS, conducted a comprehensive evaluation of the CQL program. The CQL logic model below presents a summary of the expected outputs and outcomes for the CQL program in relation to the AEOP and CQL-specific priorities. This logic model provided guidance for the overall CQL evaluation strategy.

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• ARO and AEOP co-sponsorship • ARO providing administration of program • Operations conducted by 12 Army-funded university/ college labs • 229 apprentices participating in CQL apprenticeships • 206 university/college S&Es serving as CQL mentors • Apprenticeship funds administered to university/college research labs to support apprentice participation • Centralized branding and comprehensive marketing • Centralized evaluation	• Apprentices engage in authentic STEM research experiences through hands-on summer apprenticeships at Army-funded university/college labs • University/college S&Es supervise and mentor apprentices' research • Program activities that expose students to AEOP programs and/or STEM careers in the Army or DoD	• Number and diversity of apprentice participants engaged in CQL • Number and diversity of university / college S&Es engaged in CQL • Apprentices, university / college S&Es, and ARO contributing to evaluation	• Increased apprentice STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased apprentice interest in future STEM engagement • Increased apprentice awareness of and interest in other AEOP opportunities • Increased apprentice awareness of and interest in STEM research and careers • Increased apprentice awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve URAP programs	• Increased apprentice participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased apprentice pursuit of STEM degrees • Increased apprentice pursuit of STEM careers • Increased apprentice pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of CQL

The CQL evaluation study gathered information from apprentice and mentor participants about CQL processes, resources, activities, and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and CQL program objectives.

Key Evaluation Questions

- What aspects of CQL motivate participation?
- What aspects of CQL structure and processes are working well?
- What aspects of CQL could be improved?
- Did participation in CQL:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

The assessment strategy for CQL included post-program apprentice and mentor questionnaires, site visits to 2 CQL sites, 2 focus groups with apprentices, 2 focus groups with mentors, and an Annual Program Report (APR) prepared by AAS using data from all CQL sites. Tables 5-9 outline the information collected in apprentice and mentor questionnaires and focus groups, as well as information from the APR that is relevant to this evaluation report.

Table 5. 2017 Apprentice Questionnaires

Category	Description
Profile	**Demographics:** Participant gender, grade level, and race/ethnicity
	Education Intentions: Degree level, confidence to achieve educational goals, field sought
AEOP Goal 1	**Capturing the Apprentice Experience:** In-school vs. In-program experience; mentored research experience and products
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in 21st Century Skills
	STEM Identity: Gains in STEM identity, intentions to participate in STEM, and STEM-oriented education and career aspirations; contribution of AEOP
	AEOP Opportunities: Past participation, awareness of, and interest in participating in other AEOP programs; contribution of AEOP, impact of AEOP resources
	Army/DoD STEM: Exposure to Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers, change in interest for STEM and Army/DoD STEM jobs; contribution of AEOP, impact of AEOP resources
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies (apprentices respond to a subset)
	Comprehensive Marketing Strategy: How apprentices learn about AEOP, motivating factors for participation, impact of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 6. 2017 Mentor Questionnaires

Category	Description
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of CQL, motivating factors for participation, satisfaction with and suggestions for improving CQL programs, benefits to participants

AEOP Goal 1	**Capturing the Apprentice Experience:** In-program experience
	STEM Competencies: Gains in their apprentices' Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in their apprentices' 21st Century Skills
	AEOP Opportunities: Past participation, awareness of other AEOP programs; efforts to expose apprentices to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing apprentice AEOP metrics
	Army/DoD STEM: Attitudes toward Army/DoD STEM research and careers, efforts to expose apprentices to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing apprentice Army/DoD career metrics
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies
	Comprehensive Marketing Strategy: How mentors learn about AEOP, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers

Table 7. 2017 Apprentice Focus Groups	
Category	**Description**
Profile	Gender, race/ethnicity, grade level, past participation in CQL, past participation in other AEOP programs
Satisfaction & Suggestions	Awareness of CQL, motivating factors for participation, satisfaction with and suggestions for improving CQL programs, benefits to participants
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Extent to which apprentices were exposed to other AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Extent to which apprentices were exposed to STEM and Army/DoD STEM jobs

Table 8. 2017 Mentor Focus Groups	
Category	**Description**
Profile	Gender, race/ethnicity, occupation, organization, role in SEAP, past participation in SEAP, past participation in other AEOP programs
Satisfaction & Suggestions	Perceived value of SEAP, benefits to participants, suggestions for improving SEAP programs
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Efforts to expose students to AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Efforts to expose students to STEM and Army/DoD STEM jobs
	Mentor Capacity: Local Educators – Strategies used to increase diversity/support diversity in SEAP

Table 9. 2017 Annual Program Report	
Category	**Description**
Program	Description of program content, activities, and academic level
AEOP Goal 1 and 2 Program Efforts	**Underserved Populations:** Mechanisms for marketing to and recruitment of apprentices from underserved populations
	Army STEM: Army/DoD STEM Careers –Participation of Army engineers and/or Army research facilities in career fair activities
	Mentor Capacity: Local Educators - University faculty and apprentice involvement

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in the report narrative, with tables and footnotes providing results from tests for significance. Findings of statistical and/or practical significance are noted in respective data summaries. Part 3 of the report includes appendices with information relevant to the CQL evaluation: Appendix A outlines the evaluation plan; focus group protocols are provided in Appendix B (apprentice) and Appendix C (mentor); apprentice and mentor questionnaire instruments are located in Appendix D and Appendix E, respectively. Major trends in data analyses are reported herein.

Study Sample

Table 10 provides an analysis of apprentice and mentor participation in the CQL questionnaires, the response rate, and the margin of error at the 95% confidence level[2] (a measure of how representative the sample is of the population). Although questionnaire response rates were higher than in 2016 (40% of apprentices and 10% of mentors responded in 2016 compared with 47% of apprentices and 22% of mentors in 2017), the margin of error for both the mentor and apprentice questionnaires are larger than generally considered acceptable, indicating that the samples may not be representative of their respective populations.

Table 10. 2017 CQL Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[3]
Apprentices	109	229	47.5%	±6.81
Mentors	46	206	22.3%	±12.77

Two apprentice focus groups and two mentor focus groups were conducted at two CQL sites. Twelve apprentices participated in the two apprentice focus groups. Of these apprentices, three were male and nine were female. Ten students were White, one was Black or African American, and one was "other" race or ethnicity. Four apprentices were college juniors and eight were college seniors. The two mentor focus groups were comprised of 16 mentors, all of whom were Army S&Es. Seven male mentors and nine female mentors participated in focus groups. Of these, 10 were White, three were Black or African American, one

[3] "Margin of error @ 95% confidence" means that 95% of the time, the true percentage of the population who would select an answer lies within the stated margin of error. For example, if 47% of the sample selects a response and the margin of error at 95% confidence is calculated to be 5%, if you had asked the question to the entire population, there is a 95% likelihood that between 42% and 52% would have selected that answer. A 2-5% margin of error is generally acceptable at the 95% confidence level.

was Asian, and two were other races or ethnicities. Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of questionnaire data. They add to the overall narrative of CQL's efforts and impact, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Apprentice Demographics

Demographic information collected from apprentice questionnaire respondents is summarized in Table 11. Nearly equal numbers of males (51%) and females (49%) completed the survey. The majority of apprentices reported being White (71%), followed by Asian (10%), Black or African American (7%) and Hispanic or Latino (5%). Most apprentices (74%) were college juniors and seniors. Respondent demographics are similar to the demographic distribution for the overall population of CQL apprentices.

Table 11. 2017 CQL Apprentice Respondent Profile

Demographic Category	Questionnaire Respondents	
Respondent Gender (n=109)		
Male	53	51%
Female	56	49%
Choose not to report	0	0%
Respondent Race/Ethnicity (n=109)		
Asian	11	10%
Black or African American	8	7%
Hispanic or Latino	5	5%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	1	1%
White	77	71%
Other race or ethnicity	4	4%
Choose not to report	2	2%
Respondent Grade Level (n=92)		
College freshman	1	1%
College sophomore	15	14%
College junior	34	32%
College senior	45	42%
Choose not to report	1	1%
Other	11	10%

Apprentices were asked about their previous AEOP participation (Table 12). Nearly two-thirds of apprentices (65%) reported having never participated in AEOPs in the past. Apprentices who had participated in AEOPs were most likely to have participated in CQL (15%), SEAP (13%), and GEMS (9%).

Table 12. Apprentice Reports of Participation in AEOPs (n=109)

	Response Percent	Response Total
Camp Invention	0.00%	0
eCYBERMISSION	0.92%	1
Junior Solar Sprint (JSS)	0.00%	0
Gains in the Education of Mathematics and Science (GEMS)	9.17%	10
UNITE	0.00%	0
Junior Science & Humanities Symposium (JSHS)	0.92%	1
Science & Engineering Apprenticeship Program (SEAP)	12.84%	14
Research & Engineering Apprenticeship Program (REAP)	0.00%	0
High School Apprenticeship Program (HSAP)	0.00%	0
College Qualified Leaders (CQL)	14.68%	16
Undergraduate Research Apprenticeship Program (URAP)	0.00%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0.00%	0
I've never participated in any AEOP programs	65.14%	71
Other STEM Program	16.51%	18

Mentor Demographics

Demographic data for mentors responding to the questionnaire are summarized in Table 13. Considerably more female mentors (61%) than males (35%) responded. Approximately three-quarters of the mentors (74%) reported being White. All but one responding mentor identified themselves as scientist, engineer, or mathematics professionals (98%), with biological sciences (26%), engineering (24%), and physical science (20%) being reported as the most common primary areas of research.

Table 13. 2017 CQL Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 46)		
Female	16	61%
Male	28	35%
Choose Not to Report	2	4%
Respondent Race/Ethnicity (n = 46)		
Asian	2	4%
Black or African American	2	4%
Hispanic or Latino	3	7%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	34	74%
Other race or ethnicity	1	2%
Choose not to report	4	9%
Respondent Occupation (n = 46)		
Teacher	0	0%
Other school staff	0	0%
University educator	0	0%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	0	0%
Scientist, Engineer, or Mathematics professional	45	98%
Other	1	2%
Respondent Primary Area of Research (n = 46)		
Physical science (physics, chemistry, astronomy, materials science, etc.)	9	20%
Biological science	12	26%
Earth, atmospheric, or oceanic science	0	0%
Environmental science	1	2%
Computer science	8	18%
Technology	0	0%
Engineering	11	24%
Mathematics or statistics	0	0%
Medical, health, or behavioral science	2	4%
Social Science (psychology, sociology, anthropology)	1	2%
Other, (specify):	2	4%

6 | Actionable Program Evaluation

The Actionable Program Evaluation is intended to provide assessment and evaluation of program processes, resources, and activities for the purpose of recommending improvements as the program moves forward. A focus of the Actionable Program Evaluation is to inform the long-term goal of CQL and all of the AEOPs to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technological progress. Thus, it is important to consider how CQL is marketed and ultimately recruits participants, the factors that motivate them to participate in CQL, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. The following sections report perceptions of apprentices and mentors that pertain to current programmatic efforts and recommend evidence-based improvements to help CQL achieve outcomes related to AEOP programs and objects.

Marketing and Recruiting Underrepresented and Underserved Populations

In FY17, outreach was conducted through a coordinated effort among apprenticeships. Marketing was conducted for apprenticeship programs overall rather than for individual programs, a strategy that AAS has reported to be successful. In particular, AAS noted that consistent messaging to directors, mentors, and students continues to be a successful way to keep participants informed of other AEOP programs. According to the annual program report submitted by AAS, a number of strategies were used to disseminate information about the apprenticeship programs to diverse audiences:

- Worked with CAM office to develop and publicize DoD STEM Career webinars for all apprenticeships showcasing Army scientists and engineers.
- Students learned about Army STEM careers through direct engagement with Army scientists and engineers in DoD laboratories.
- Worked with Widmeyer and Metriks to profile mentors in universities and DoD laboratories to showcase STEM careers in AEOP blogs and Alumni Spotlights.
- Since last year's ongoing summer communication was successful, continued this effort in FY17, sending student and mentor information on the following topics:
    - STEM Career links and FY17 STEM Career flyer
    - DoD STEM Webinar
    - Alumni Survey Link
    - Other AEOP programs
    - AEOP Travel Award
    - 21st Century Skill Assessment Pilot Program
    - Program Evaluation
    - Poster tips

- Monthly marketing efforts were targeted to high schools located within a two-hour radius of each SEAP lab.
- Updated the Apprenticeship flyer showing diversity and individual program descriptions.
- Cross marketing and outreach for all AEOP programs, in addition to specific cross promotion, such as:
    - Provided apprenticeship flyers to the National Science Teachers Association (NSTA) and the Junior Science Humanities Symposium (JSHS) for distribution at events.
    - Assisted eCYBERMISSION with virtual judge recruitment by notifying apprenticeship directors and mentors of the opportunity.
    - Assisted RESET in recruiting mentors in Army labs to mentor a teacher, in addition to an apprentice. This resulted in recruiting some interested mentors for RESET.

Mentors were asked how apprentices were recruited for CQL (Table 14). Mentors most frequently reported that apprentices were recruited through colleague(s) in their workplace (41%), followed by AEOP Applications (24%), and university faculty outside of their workplace (22%). Close to a quarter (22%) of participating mentors reported not knowing how their apprentices had been recruited for CQL.

Table 14. Mentor Reports of Recruitment Strategies (n=46)

	Response Percent	Response Total
Applications from the Army Educational Outreach Program (AEOP) Website	23.91 %	11
Personal acquaintance(s) (friend, family, neighbor, etc.)	17.39 %	8
Colleague(s) in my workplace	41.30 %	19
K-12 school teacher(s) outside of my workplace	2.17 %	1
University faculty outside of my workplace	21.74 %	10
Informational materials sent to K-12 schools or Universities outside of my workplace	8.70 %	4
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	2.17 %	1
Communication(s) generated by a university or faculty (newsletter, email blast, website)	8.70 %	4
STEM or STEM Education conference(s) or event(s)	6.52 %	3
Organization(s) that serve underserved or underrepresented populations	2.17 %	1
The student contacted me (the mentor) about the program	19.57 %	9
I do not know how student(s) were recruited for CQL	21.74 %	10
Other [†], (specify):	10.87 %	5

[†] Other = career fair; knew student from GEMS; student's professor contacted me; the student contact another ARL employee and was referred to me; RDECOM/AMRDEC

In order to understand which recruitment methods are most effective, apprentices were asked to select all of the different ways they had learned about AEOP (Table 15). Apprentices reported a variety of sources of information about AEOP. The most frequently selected sources of information, selected by a quarter or more of apprentices, included someone who works with the DoD (33%), someone who works with the program (28%), and someone who works at the school/university the apprentice attends (25%). These findings suggest that personal connections were a key source of AEOP information for CQL apprentices.

Table 15. How Apprentices Learned About AEOP (n=109)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	6.42%	7
AEOP on Facebook, Twitter, Instagram, or other social media	0.00%	0
School or university newsletter, email, or website	9.17%	10
Past participant of program	17.43%	19
Friend	22.02%	24
Family Member	20.18%	22
Someone who works at the school or university I attend	24.77%	27
Someone who works with the program	27.52%	30
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	33.03%	36
Community group or program	0.92%	1
Choose Not to Report	2.75%	3

Apprentices participating in focus group data also reported learning about CQL primarily through personal connections, citing parents, siblings, friends, and professors as sources of information. One apprentice also reported learning about CQL during her SEAP apprenticeship.

Mentors were also asked how they learned about AEOP (Table 16). Approximately half (52%) of mentors reported learning about AEOP through someone who works with the DoD. Other sources of information (cited by 16% of participants) included the AEOP website and past participants of the program.

Table 16. How Mentors Learned About AEOP (n=31)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	16.13%	5
AEOP on Facebook, Twitter, Instagram, or other social media	0.00%	0
School or university newsletter, email, or website	3.23%	1
Past participant of program	16.13%	5
Friend	6.45%	2
Family Member	0.00%	0
Someone who works at the school or university I attend	0.00%	0
Someone who works with the program	16.13%	5
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	51.61%	16
Community group or program	0.00%	0
Choose Not to Report	9.68%	3

Overall, personal connections continue to be a major source of information about AEOP and CQL for both apprentices and mentors. One mentor focus group participant acknowledged the difficulty of reducing the role of personal connections in recruiting apprentices and offered a possible solution:

> *The hardest part is finding the right student outside of the friends and family network. If students applied to specific projects then the mentors would have a smaller less intimidating pile of resumes to look through. ARL participated in a summer research initiative with ICT where the students that applied picked their top three subjects of interest. They picked us and we picked them, and the majority of these students were outside of the friends and family network.* (CQL Mentor)

Factors Motivating Apprentice Participation

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in CQL. (Table 17). The most frequently selected motivators for participating in CQL related to apprentices' educational interests and learning. More than 80% of apprentices indicated that they were motivated to participate in CQL by a desire to learn something new or interesting (91%), interest in STEM (90%), desire to expand laboratory or research skills (89%), learning in ways that are not possible in school (81%), and the opportunity to use advanced laboratory technology (80%).

Table 17. Factors Motivating Apprentices to Participate in CQL (n=109)

	Response Percent	Response Total
Teacher or professor encouragement	19.27%	21
An academic requirement or school grade	8.26%	9
Desire to learn something new or interesting	90.83%	99
The mentor(s)	56.88%	62
Building college application or résumé	61.47%	67
Networking opportunities	74.31%	81
Interest in science, technology, engineering, or mathematics (STEM)	89.91%	98
Interest in STEM careers with the Army	63.30%	69
Having fun	42.20%	46
Earning stipends or awards for doing STEM	33.94%	37
Opportunity to do something with friends	4.59%	5
Opportunity to use advanced laboratory technology	79.82%	87
Desire to expand laboratory or research skills	88.99%	97
Learning in ways that are not possible in school	80.73%	88
Serving the community or country	62.39%	68
Exploring a unique work environment	69.72%	76
Figuring out education or career goals	66.97%	73
Seeing how school learning applies to real life	61.47%	67
Recommendations of past participants	14.68%	16
Choose Not to Report	0.00%	0

Apprentices participating in focus groups were also asked why they chose to participate in CQL. Apprentices cited a variety of motivators, emphasizing the value of research experience, networking opportunities, and career information.

The CQL Experience

The apprentice questionnaire included several items asking about the nature of apprentices' experiences in CQL, and how those experiences compared to their STEM learning opportunities in school. Apprentices were asked to report on their input into the design of their project (Table 18). No apprentices reported independently designing their entire project, however 46% indicated they had some input or choice in project design. Approximately half of apprentices reported being assigned a project by their mentors (51%).

Table 18. Apprentice Input on Design of Their Project (n=107)

	Response Percent	Response Total
I did not have a project	2.80 %	3
I was assigned a project by my mentor	51.40 %	55
I worked with my mentor to design a project	14.95 %	16
I had a choice among various projects suggested by my mentor	20.56 %	22
I worked with my mentor and members of a research team to design a project	10.28 %	11
I designed the entire project on my own	0.00 %	0

Apprentices were also asked about their participation in research groups (Table 19). Although most apprentices reported working in close proximity with others during CQL, they tended to work independently on their projects (65%). Few (14%) worked in isolation with their research mentor, and approximately 21% of apprentices worked collaboratively in a group on the same project.

Table 19. Apprentice Participation in a Research Group (n=107)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	14.02 %	15
I worked with others in a shared laboratory or other space, but we worked on different projects	28.04 %	30
I worked alone on my project and I met with others regularly for general reporting or discussion	21.50 %	23
I worked alone on a project that was closely connected with projects of others in my group	15.89 %	17
I worked with a group who all worked on the same project	20.56 %	22

A goal of CQL is to increase the number of students who pursue STEM careers. As such, apprentices were asked how many jobs/careers in STEM in general, and STEM jobs/careers in the DoD more specifically, they learned about during their CQL experiences (Tables 20 and 21). A large majority of apprentices (94%) reported learning about at least one STEM job/career, and most (72%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (92%) reported learning about at least one DoD STEM job/career, although somewhat fewer (66%) reported learning about 3 or more Army or DoD STEM jobs during CQL.

Table 20. Number of STEM Jobs/Careers Apprentices Learned About During CQL (n=107)

	Response Percent	Response Total

None	6.54 %	7
1	7.48 %	8
2	14.02 %	15
3	15.89 %	17
4	8.41 %	9
5 or more	47.66 %	51

Table 21. Number of Army of DoD STEM Jobs/Careers Apprentices Learned About During CQL (n=107)

	Response Percent	Response Total
None	8.41 %	9
1	5.61 %	6
2	19.63 %	21
3	17.76 %	19
4	6.54 %	7
5 or more	42.06 %	45

Apprentices participating in focus groups were also asked about whether and how they learned about Army or DoD STEM careers during CQL. All participants reported learning about these careers, citing mentors and the experience of being in an Army lab as sources of information. Focus group participants reported that they had not received career information directly from the AEOP.

Apprentices were also asked in a questionnaire item to report on the impact of various resources on their awareness of DoD STEM careers (Table 22). Participation in CQL (84%) and apprentices' mentors (88%) were most often reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. The vast majority of apprentices reported that they either had not experienced AEOP resources such as the AEOP brochure and AEOP on social media or found them not impactful on their awareness of DoD STEM careers.

Table 22. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=107)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	31.8%	16.8%	24.3%	17.8%	9.3%	
	34	18	26	19	10	**107**
AEOP on Facebook, Twitter or other social media	73.8%	17.8%	3.7%	3.7%	0.9%	
	79	19	4	4	1	**107**
Army Research Office (ARO) website	58.9%	16.8%	9.3%	9.3%	5.6%	
	63	18	10	10	6	**107**
AEOP brochure	61.7%	19.6%	9.3%	7.5%	1.9%	
	66	21	10	8	2	**107**
My Apprenticeship Program mentor	1.9%	0.9%	13.1%	21.5%	62.6%	
	2	1	14	23	67	**107**
Presentations or information shared in the Apprenticeship Program	20.6%	7.5%	16.8%	29.0%	26.2%	
	22	8	18	31	28	**107**
Participation in the Apprenticeship Program	1.9%	2.8%	7.5%	23.4%	64.5%	
	2	3	8	25	69	**107**

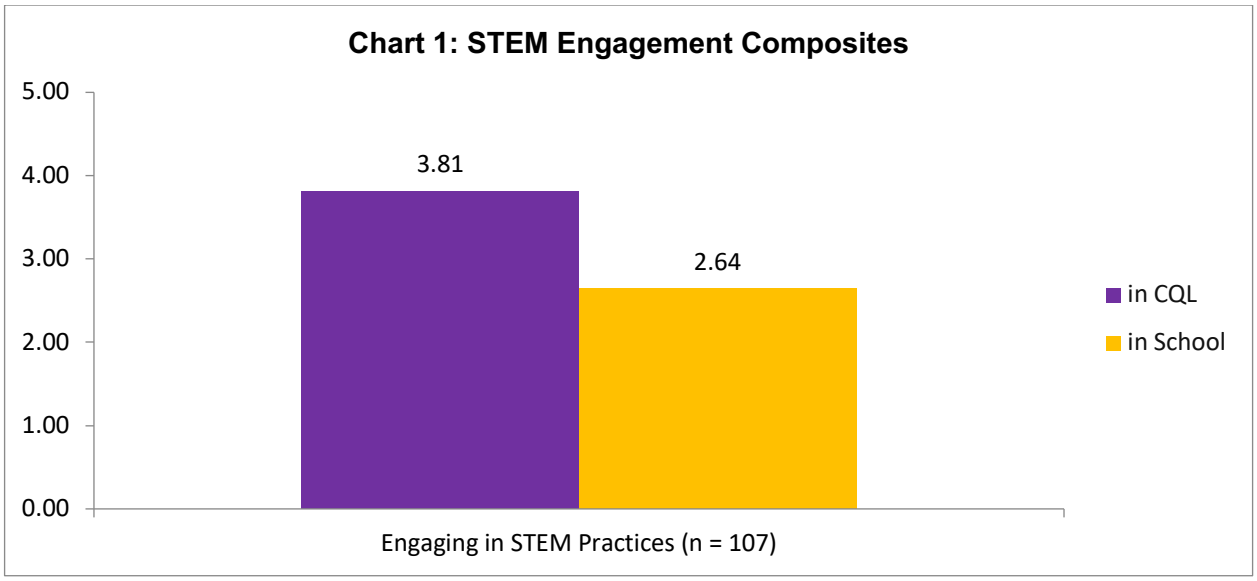
Apprentices were asked to indicate how often they engaged in various STEM practices during CQL. Overall results indicate that apprentices were actively engaged in STEM practices during the program (Table 23). The majority of apprentices reported participating in all activities at least monthly with the exception of presenting their STEM research to a panel of judges and building/making a computer model. STEM practices apprentices reported being engaged in most frequently (weekly or every day) during CQL were interacting with STEM researchers (94%) and working with a STEM researcher or company on a real-world STEM research project (89%).

Table 23. Apprentice Engagement in STEM Practices in CQL (n=107)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM	2.8%	4.7%	3.7%	6.5%	82.2%	
	3	5	4	7	88	**107**
Work with a STEM researcher on a research project of your own	29.0%	13.1%	3.7%	9.3%	44.9%	
	31	14	4	10	48	**107**
Design my own research or investigation based on my own	24.3%	19.6%	7.5%	15.0%	33.6%	
	26	21	8	16	36	**107**
Present my STEM research to a panel of judges from industry or the	17.8%	57.0%	14.0%	4.7%	6.5%	
	19	61	15	5	7	**107**
Interact with STEM researchers	0.9%	4.7%	0.9%	4.7%	88.8%	
	1	5	1	5	95	**107**
Use laboratory procedures and tools	11.2%	7.5%	2.8%	18.7%	59.8%	
	12	8	3	20	64	**107**
Identify questions or problems to investigate	1.9%	8.4%	6.5%	20.6%	62.6%	
	2	9	7	22	67	**107**
Design and carry out an investigation	6.5%	15.0%	10.3%	16.8%	51.4%	
	7	16	11	18	55	**107**
Analyze data or information and draw conclusions	1.9%	7.5%	10.3%	17.8%	62.6%	
	2	8	11	19	67	**107**
Work collaboratively as part of a team	4.7%	10.3%	3.7%	16.8%	64.5%	
	5	11	4	18	69	**107**
Build or make a computer model	43.0%	13.1%	7.5%	9.3%	27.1%	
	46	14	8	10	29	**107**
Solve real world problems	7.5%	8.4%	8.4%	12.1%	63.6%	
	8	9	9	13	68	**107**

A composite score[3] was calculated for items related to apprentices' STEM Engagement in CQL.[4] Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and the total across all items in each scale was calculated. The composite scores were used to test whether there were differences in apprentice experiences by gender and race/ethnic group (minority vs. non-minority apprentices). For both sets of items, there were no significant differences in composite scores by gender or race/ethnic group.

To examine how apprentices' engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school. These responses were also combined into a composite variable[5] parallel to the STEM Engagement in CQL variable. Chart 1 shows that apprentices' engagement in STEM practices in CQL were significantly higher than their engagement in the same practices in school (effect size is extremely large with d = 2.61)[6]. These data indicate that CQL provides apprentices with more intensive engagement in STEM than they typically experience in school.



[3] Using multiple statistical tests on related outcomes requires the use of a Type I error rate adjustment to reduce the likelihood of false positives (i.e., detecting a difference when one does not truly exist). However, Type I error rate adjustments lead to a reduction in statistical power (i.e., the ability to detect a difference if it does exist). The use of a composite score helps avoid both of these problems by reducing the total number of statistical tests used. In addition, composite scores are typically more reliable than individual questionnaire items.

[4] The Cronbach's alpha reliability for these 12 items was 0.832.

[5] Cronbach's alpha reliability for these 12 items was 0.850.

[6] Dependent Samples t-test for STEM Engagement: t(106)=13.46, p<.001.

Apprentices participating in focus groups were asked to comment on how their CQL experiences compared to their typical school experiences. All participants indicated that their CQL experiences provided them with unique opportunities for hands-on application of knowledge that they typically do not have in their school settings. Several participants also indicated that they appreciated having more time to learn and understand than they have in their school-based laboratory experiences.

The Role of Mentors

Mentors play a critical role in the CQL program. Mentors supervise and support apprentices' work, advise apprentices on educational and career paths, and generally serve as STEM role models for CQL apprentices. The majority of mentors (70%) responding to the mentor questionnaire reported working with 1 apprentice while 22% of mentors worked with 2 apprentices and 9% reported working with 3 or 4 apprentices.

Mentors were asked whether or not they used a number of strategies when working with their apprentices (note: the questionnaires used the term "students"; consequently, the data in this section are reported using that term as well). These strategies comprised five main areas of effective mentoring:[7]

1. Establishing the relevance of learning activities;
2. Supporting the diverse needs of students as learners;
3. Supporting students' development of collaboration and interpersonal skills;
4. Supporting students' engagement in "authentic" STEM activities; and
5. Supporting students' STEM educational and career pathways.

Mentors reported using most strategies associated with each of the five mentoring areas listed above. Mentor responses for each of the five areas of mentoring are presented in Tables 23 – 27.

[7] Mentoring strategies examined in the evaluation were best practices identified in various articles including:

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education*, *95*(5), 877-907.

Ornstein, A. (2006). The frequency of hands-on experimentation and student attitudes toward science: A statistically significant relation (2005-51-Ornstein). *Journal of Science Education and Technology*, *15*(3-4), 285-297.

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, *96*(3), 411-427.

Large proportions of participating mentors reported using several strategies to help make learning activities relevant to students (Table 24). For example, more than 90% reported becoming familiar with their students' background sand interests (98%) and giving students real-life problems to investigate or solve (91%). Strategies used somewhat less frequently were helping students understand how STEM can help them improve their own community (63%) and helping students become aware of the role(s) that STEM plays in their everyday lives (52%).

Table 24. Mentors Using Strategies to Establish Relevance of Learning Activities (n=46)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the CQL experience	97.8%	2.2%	
	45	1	**46**
Giving students real-life problems to investigate or solve	91.3%	8.7%	
	42	4	**46**
Selecting readings or activities that relate to students' backgrounds	87.0%	13.0%	
	40	6	**46**
Encouraging students to suggest new readings, activities, or projects	84.8%	15.2%	
	39	7	**46**
Helping students become aware of the role(s) that STEM plays in their everyday lives	47.8%	52.2%	
	22	24	**46**
Helping students understand how STEM can help them improve their own community	37.0%	63.0%	
	17	29	**46**
Asking students to relate real-life events or activities to topics covered in CQL	54.3%	45.7%	
	25	21	**46**

Similarly, mentors reported using a variety of strategies to support the diverse needs of students as learners (Table 25). More than three-quarters of mentors reported using a variety of teaching and/or mentoring activities to meet the needs of all students (83%) and directing students to other individuals or programs for additional support as needed (80%). Fewer mentors reported highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (22%).

Table 25. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=46)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the CQL experience	65.2%	34.8%	
	30	16	**46**
Interact with students and other personnel the same way regardless of their background	73.9%	26.1%	
	34	12	**46**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	82.6%	17.4%	
	38	8	**46**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	43.5%	56.5%	
	20	26	**46**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	71.7%	28.3%	
	33	13	**46**
Directing students to other individuals or programs for additional support as needed	80.4%	19.6%	
	37	9	**46**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	21.7%	78.3%	
	10	36	**46**

Most mentors reported using all strategies to support students' development of collaboration and interpersonal skills (Table 26). Over three-quarters of mentors (76%-96%) reported using all strategies except allowing students to resolve conflicts and reach agreement within their teams (59%).

Table 26. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=46)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
	87.0%	13.0%	

Having my student(s) tell other people about their backgrounds and interests	40	6	**46**
Having my student(s) explain difficult ideas to others	87.0%	13.0%	
	40	6	**46**
Having my student(s) listen to the ideas of others with an open mind	95.7%	4.3%	
	44	2	**46**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	76.1%	23.9%	
	35	11	**46**
Having my student(s) give and receive constructive feedback with others	84.8%	15.2%	
	39	7	**46**
Having students work on collaborative activities or projects as a member of a team	87.0%	13.0%	
	40	6	**46**
Allowing my student(s) to resolve conflicts and reach agreement within their team	58.7%	41.3%	
	27	19	**46**

When asked about strategies to support students' engagement in authentic STEM activities (Table 27), all responding mentors reported allowing students to work independently to improve their self-management abilities. A large majority (80%-98%) of mentors reported using all other strategies to support student engagement in authentic STEM activities.

Table 27. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=46)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	87.0%	13.0%	
	40	6	**46**
Having my student(s) search for and review technical research to support their work	93.5%	6.5%	
	43	3	**46**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	93.5%	6.5%	
	43	3	**46**
Supervising my student(s) while they practice STEM research skills	91.3%	8.7%	
	42	4	**46**

Providing my student(s) with constructive feedback to improve their STEM competencies	97.8%	2.2%	
	45	1	**46**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	46	0	**46**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	80.4%	19.6%	
	37	9	**46**
Encouraging students to seek support from other team members	95.7%	4.3%	
	44	2	**46**

The last series of items about mentoring strategies focused on supporting students' STEM educational and career pathways (Table 28). Almost all (96%) responding mentors reported asking students about their educational and career interests. Most also discussed STEM career opportunities within the DoD or other government agencies (89%) and provided guidance about educational pathways that will prepare students for a STEM career (74%). Less than half of mentors reported engaging activities such as recommending AEOPs that align with students' goals (44%) and helping students build a professional network in a STEM field (41%).

Table 28. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=46)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	95.7%	4.3%	
	44	2	**46**
Recommending extracurricular programs that align with students' goals	50.0%	50.0%	
	23	23	**46**
Recommending Army Educational Outreach Programs that align with students' goals	43.5%	56.5%	
	20	26	**46**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	73.9%	26.1%	
	34	12	**46**
Discussing STEM career opportunities within the DoD or other government agencies	89.1%	10.9%	
	41	5	**46**
Discussing STEM career opportunities in private industry or academia	65.2%	34.8%	
	30	16	**46**
Discussing the economic, political, ethical, and/or social context of a STEM career	39.1%	60.9%	
	18	28	**46**

Recommending student and professional organizations in STEM to my student(s)	41.3%	58.7%	
	19	27	**46**
Helping students build a professional network in a STEM field	41.3%	58.7%	
	19	27	**46**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	39.1%	60.9%	
	18	28	**46**

Mentors were asked which of the AEOP programs they explicitly discussed with their students during CQL. Table 29 displays results and shows that the most frequently discussed program, discussed by more than half of the mentors, was CQL (65%). Approximately a third of mentors (35%) reported discussing SMART with their apprentices. While 20% of mentors reported discussing AEOPs in general but without reference to any specific program, few mentors (0%-9%) discussed any other AEOPs with apprentices.

Table 29. Mentors Explicitly Discussing AEOPs with Apprentices (n=46)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
College Qualified Leaders (CQL)	65.2%	34.8%	
	30	16	**46**
GEMS Near Peer Mentor Program	8.7%	91.3%	
	4	42	**46**
Undergraduate Research Apprenticeship Program (URAP)	0.0%	100.0%	
	0	46	**46**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	34.8%	65.2%	
	16	30	**46**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	4.3%	95.7%	
	2	44	**46**
I discussed AEOP with my student(s) but did not discuss any specific program	19.6%	80.4%	
	9	37	**46**

Mentors were asked how useful various resources were in their efforts to expose students to AEOPs (Table 30). Participation in CQL was most commonly reported (78%) as somewhat or very much useful for this purpose. Most mentors reported that they did not experience materials provided by AEOP such as social media (91%), the AEOP brochure (78%), and the AEOP website (61%) as resources for exposing students to AEOPs.

Table 30. Usefulness of Resources for Exposing Students to AEOPs (n=45-46)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	60.9%	4.3%	13.0%	8.7%	13.0%	
	28	2	6	4	6	**46**
AEOP on Facebook, Twitter, Pinterest or other social media	91.3%	4.3%	2.2%	2.2%	0.0%	
	42	2	1	1	0	**46**
AEOP brochure	78.3%	2.2%	10.9%	2.2%	6.5%	
	36	1	5	1	3	**46**
CQL Program administrator or site coordinator	34.8%	2.2%	15.2%	13.0%	34.8%	
	16	1	7	6	16	**46**
Invited speakers or "career" events	69.6%	4.3%	4.3%	15.2%	6.5%	
	32	2	2	7	3	**46**
Participation in CQL	11.1%	2.2%	8.9%	28.9%	48.9%	
	5	1	4	13	22	**45**

Mentors were also asked how useful these resources were for exposing students to DoD STEM careers (Table 31). As with the previous item, mentors were most likely to rate participation in CQL as useful, with 80% selecting this as a somewhat or very much useful resource. The program administrator or site coordinator was perceived to be at least somewhat useful by 46% of responding mentors. Most mentors had not experienced AEOP materials such as AEOP on social media (91%), the AEOP brochure (85%), and the It Starts Here! Magazine (94%) as resources for exposing students to DoD STEM careers.

Table 31. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=46)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	71.7%	4.3%	6.5%	10.9%	6.5%	
	33	2	3	5	3	**46**
AEOP on Facebook, Twitter, Pinterest or other social media	91.3%	4.3%	2.2%	2.2%	0.0%	
	42	2	1	1	0	**46**
AEOP brochure	84.8%	4.3%	4.3%	4.3%	2.2%	
	39	2	2	2	1	**46**
It Starts Here! Magazine	93.5%	4.3%	2.2%	0.0%	0.0%	
	43	2	1	0	0	**46**
CQL Program administrator or site coordinator	39.1%	0.0%	15.2%	19.6%	26.1%	
	18	0	7	9	12	**46**
Invited speakers or "career" events	58.7%	2.2%	8.7%	15.2%	15.2%	
	27	1	4	7	7	**46**
Participation in CQL	13.0%	0.0%	6.5%	26.1%	54.3%	
	6	0	3	12	25	**46**

Satisfaction with CQL

Apprentices were asked how satisfied they were with a number of features of the CQL program (Table 32). More than half of responding apprentices were somewhat or very much satisfied with most of the listed program features. Features apprentices reported being most satisfied with included the teaching/mentoring provided during CQL (92%), the physical location of program activities (90%), and the amount of the stipend (89%). Few apprentices expressed dissatisfaction with most CQL program features although 17% of students were not satisfied with administrative tasks such as in-processing and networking and 8% were not satisfied with the timeliness of stipend payments.

Table 32. Student Satisfaction with CQL Program Features (n=107)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	1.9%	5.6%	15.0%	36.4%	41.1%	
	2	6	16	39	44	**107**
Other administrative tasks (e.g. security clearances, issuing CAC cards)	2.8%	16.8%	29.9%	29.0%	21.5%	
	3	18	32	31	23	**107**
Communicating with your host site organizers	4.7%	4.7%	12.1%	26.2%	52.3%	
	5	5	13	28	56	**107**
The physical location(s) of Apprenticeship Program activities	0.0%	2.8%	7.5%	17.8%	72.0%	
	0	3	8	19	77	**107**
The variety of STEM topics available to you in the Apprenticeship Program	2.8%	1.9%	15.0%	24.3%	56.1%	
	3	2	16	26	60	**107**
Teaching or mentoring provided during Apprenticeship Program activities	0.0%	1.9%	6.5%	14.0%	77.6%	
	0	2	7	15	83	**107**
Amount of stipend (payment)	0.0%	1.9%	9.3%	21.5%	67.3%	
	0	2	10	23	72	**107**
Timeliness of receiving stipend (payment)	0.0%	8.4%	11.2%	14.0%	66.4%	
	0	9	12	15	71	**107**
Research abstract preparation requirements	3.7%	4.7%	17.8%	28.0%	45.8%	
	4	5	19	30	49	**107**

Apprentices were also asked about the availability of their mentors during CQL (Table 33). Nearly all apprentices reported that their mentor was available at least half of the time (95%), and two-thirds (65%) indicated their mentor was always available.

Table 33. Apprentice Reports of Availability of Mentors (n=107)

	Response Percent	Response Total
I did not have a mentor	0.00 %	0
The mentor was never available	0.00 %	0
The mentor was available less than half of the time	4.67 %	5
The mentor was available about half of the time of my project	5.61 %	6
The mentor was available more than half of the time	24.30 %	26
The mentor was always available	65.42 %	70

Apprentices were asked about their satisfaction with various elements of their research experience (Table 34). More than two-thirds indicated being "very much" satisfied with all elements of their experience (ranging from 67% - 84%). The vast majority of apprentices reported being at least "somewhat" satisfied with each experience (ranging from 80%-94%).

Table 34. Apprentice Satisfaction with Their Experience (n=107)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.9%	2.8%	12.1%	84.1%	
	0	1	3	13	90	**107**
My working relationship with the group or team	12.1%	0.9%	0.0%	13.1%	73.8%	
	13	1	0	14	79	**107**
The amount of time I spent doing meaningful research	0.9%	3.7%	15.0%	13.1%	67.3%	
	1	4	16	14	72	**107**
The amount of time I spent with my research mentor	0.0%	1.9%	4.7%	18.7%	74.8%	
	0	2	5	20	80	**107**
The research experience overall	0.0%	1.9%	4.7%	17.8%	75.7%	
	0	2	5	19	81	**107**

An open-ended item on the questionnaire asked apprentices about their overall satisfaction with their CQL experience. Nearly all (96%) of the 105 apprentices who responded to the question had something positive to say about their experience. Many apprentice comments were simple affirmations of the program. For example, apprentice comments included "Very happy to have participated in this program, a very valuable experience" and "It was amazing! This was a once in a lifetime experience and I really

enjoyed it. I learned a lot." Other apprentices provided more nuanced comments about their experience, focusing on their satisfaction with the research experience and their mentors. For example,

> *I have had a fantastic experience. I owe a lot to my mentors who guided me every step of the way. Thanks to them, I have had the opportunity of publishing scientific articles, giving talks at conferences, and performing cutting edge research. I recently was accepted into graduate school for Ph.D. studies and I believe a major part of my acceptance was the experience I gained from this program.* (CQL Apprentice)

> *My mentor allowed me to define my project and design it in a way that I saw fit. On my second week, I was able to present my project proposal to the department head and work through issues and differences as a peer. This is one of the aspects I found most valuable, I was never treated as an intern. If I needed help it was always there for me but my capabilities were never questioned and my hand was never held. I was given the full experience of working as a research scientist.* (CQL Apprentice)

> *Before my apprenticeship, I wasn't really sure if I wanted to continue my education after my bachelor's, but now I know that I definitely want to pursue a Ph.D. and do research for the rest of my life. My mentors were some of the most encouraging, supportive, and patient people I have ever met and I will always be grateful for the opportunity I had to work with them. I feel a lot better about the future now than I did before I started the program.* (CQL Apprentice)

Twenty apprentice respondents (19%) provided positive comments about their CQL experiences but also offered some caveats. The most frequently mentioned caveat was computer access and the CAC process. Other caveats included comments about program organization, timely payment of stipends, and availability of mentors. For example,

> *It took 4 weeks to gain access to a CAC card and it wasn't until the 5th week I gained access to a computer. I was contacted about the opportunity to work with AEOP in March and home from school ready to work in May; [it] was frustrating that when I started work, I had to wait another month before I could gain access. Most of my projects required computer access. Overall, my experience with AEOP was great and I am very thankful for the opportunity to work with the Army.* (CQL Apprentice)

> *I was very happy with my mentor and how welcoming and helpful he was all summer. However, I felt the program was EXTREMELY unorganized, and I was very unhappy that I didn't get a CAC all summer. Not having a CAC made it super difficult to complete my project and get the information I needed from online.* (CQL Apprentice)

> *I am fairly satisfied with my apprenticeship. I was able to network with many people that I believe I will stay in contact with throughout my career. I learned new techniques that I know will help me*

in my future. I am unsatisfied with the [delay in] receiving my stipend. I was depending on this money to pay for my housing during the apprenticeship and I have still not been paid. I began my apprenticeship June 11th and I will be finishing August 11th. Today is July 25th and I have still not received any stipend. (CQL Apprentice)

Only 4 apprentices (4%) had no positive comments about their CQL experiences. The most frequently mentioned area of dissatisfaction was computer access/CAC process.

Apprentices were also asked in an open-ended questionnaire item to identify three ways in which CQL could be improved. Of the 101 apprentices who provided at least one suggestion for improvement, 37 comments included suggestions for improving in in-processing and CAC access. Another 31 responses focused on improvements in mentor communication and the apprentice work experience, including providing more mentor-apprentice communication (e.g., schedules, expectations, and feedback) (7 comments), more mentor contact (7 comments), ensuring that mentors are prepared to work with apprentices (6 comments), providing more work or more diverse work for apprentices (5 comments), providing workshops or seminars for apprentices (5 comments), and providing the opportunity for group projects (1 comment). Twenty-four comments focused on stipends, with 12 comments about the timeliness or frequency of payments, 7 suggesting that the stipend be increased, 3 that tax information be made clearer to apprentices, and 2 suggestions for overtime pay. Other improvements mentioned in 15 or more responses included improving communication between the program and apprentices (23 comments), streamlining the application process and paperwork (19 comments), providing apprentices with exposure to areas of research outside of their mentors' research (17 comments), and other administrative issues (16 comments) such as lengthening the program, providing housing assistance, providing travel funding, and adjusting the start and end dates of apprenticeships to align with college students' schedules.

Apprentices participating in focus groups were also asked for their opinions about how the CQL program could be improved. Their responses highlighted many of the same issues described in questionnaire responses, including suggestions for improving computer access and CAC card processing, program communication with apprentices, providing seminars and workshops for apprentices (e.g., how to create a CV, professional networking), aligning apprenticeship dates with college schedules, and timely payment of stipends. Focus group participants also suggested that more opportunities be provided for apprentices to interact with one another, that the program be advertised more effectively, and that the AEOP provide more information about other programs and about careers and networking.

Mentors also generally reported being somewhat or very much satisfied with the program components they experienced (Table 35). More than half of mentors reported being somewhat or very much satisfied with all program features. For example, 67% of mentors were at least somewhat satisfied with research abstract requirements and 63% with communications with CQL coordinators. Many mentors had not experienced program features such as communication with AAS (63% had not experienced) and the application or registration process (37% had not experienced). Few mentors expressed dissatisfaction

with program features although 17% reported being "not at all" satisfied with administrative tasks such as in-processing and network access.

Table 35. Mentor Satisfaction with CQL Program Features (n=46)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	37.0%	6.5%	6.5%	21.7%	28.3%	
	17	3	3	10	13	**46**
Other administrative tasks (in-processing, network access, etc.)	21.7%	17.4%	8.7%	23.9%	28.3%	
	10	8	4	11	13	**46**
Communicating with Academy of Applied Science (AAS)	63.0%	4.3%	4.3%	10.9%	17.4%	
	29	2	2	5	8	**46**
Communicating with CQL organizers	21.7%	4.3%	10.9%	21.7%	41.3%	
	10	2	5	10	19	**46**
Support for instruction or mentorship during program activities	23.9%	4.3%	15.2%	23.9%	32.6%	
	11	2	7	11	15	**46**
Amount of Stipends (payment)	47.8%	0.0%	2.2%	17.4%	32.6%	
	22	0	1	8	15	**46**
Timeliness of stipend payment	56.5%	0.0%	2.2%	13.0%	28.3%	
	26	0	1	6	13	**46**
Research abstract preparation requirements	17.4%	6.5%	8.7%	26.1%	41.3%	
	8	3	4	12	19	**46**

Mentors were also asked to respond to open-ended items asking for their opinions about the program. When asked about their satisfaction with CQL 23 of the 30 respondents (77%) had something positive to say, focusing on the opportunities for student learning, students' lab experience, and ease of working with the program. For example,

> *This program provides full immersion of students into nonacademic labs to gain further experience in STEM programs to understand other available professional paths. It is an excellent summer program and I wish I had participated when I was in college.* (CQL Mentor)

> *I was very satisfied with CQL this summer. It was an easy process of selecting a student and getting them on boarded with enough time to meaningfully contribute to a project over the summer. I'm*

a huge fan of internships and mentoring in general, and CQL makes my life easier when it comes to the administrative side of things. Thanks for all the work you do! (CQL Mentor)

Five of the responding apprentices made positive comments, but also offered caveats focusing on security processes and computer access and the evaluation questionnaire. For example,

Overall, I am very supportive of the CQL program. I've mentored a number of talented your people in CQL whose projects even led to peer-reviewed scientific publications. I expect to mentor many more students in the future. However, security has become an increasing barrier. For the first time this summer, students were completely denied access to networked computers. There was also a requirement that students be escorted at all times. These restrictions are a great burden to the mentor and the student. The program will never work well until these constraints are lifted. (CQL Mentor)

The other 7 respondents (23%) had no positive comments about the program. Areas of mentor dissatisfaction included in-processing and computer access, communication from the program, and the amount of paperwork associated with the program. For example,

The volume of surveys and excessive paperwork takes away precious time from interacting with the students. Start certificate and encouraging goal setting seem reasonable. Signing a paper every time we meet is an excessive requirement. (CQL Mentor)

Another open-ended item asked mentors to identify the three most important strengths of CQL. Forty mentors identified at least one benefit of the program. While a variety of important benefits of the program were listed, the most frequently described (mentioned in 27 comments) was the opportunity for apprentices to gain laboratory experience and experience research in a real-world setting. Nineteen mentor comments focused on the qualities of apprentices as benefits, including the high quality of students CQL attracts, the diversity of apprentices, and students' contributions to research. Responding mentors expressed satisfaction with the administration of CQL, with 17 respondents citing administrative features such as ease of participation, cost, and choice of students as strengths of CQL. Other strengths of the program included the stipend (10 comments), networking opportunities for apprentices (5 comments), career exploration (5 comments), exposure to DoD research and careers (5 comments), and the mentor-apprentice relationship (5 comments).

Mentors participating in focus groups echoed several of these strengths including the value of hands-on workplace experience for students, the opportunity to develop laboratory skills and workplace skills, and the opportunity to apply knowledge. These mentors added that participating in CQL had benefited them by giving them the opportunity to learn about interacting with and teaching diverse students, receiving help with their own workload, and the satisfaction of helping to develop the future workforce.

Mentors were also asked in an open-ended questionnaire item to identify three ways in which CQL could be improved. The 32 mentors who identified at least one area for improvement focused on administrative features of CQL (mentioned in 31 comments), including suggestions for streamlining in-processing and computer access, providing more information to mentors, improving communication with program organizers, providing mentors with more information about AEOP, and increasing the marketing and/or outreach activities for CQL. Another 12 comments focused on improvements in program logistics including opening the program to graduate students, lengthening the program, increasing the number of participants, and increasing the number of CQL sites. Ten comments focused on aspects of the apprentice experience, including providing opportunities for student to student networking, providing workshops or seminars, and providing lab safety training.

Mentors participating in focus groups also offered a variety of suggestion for program improvement. Several comments focused on streamlining the in-processing and computer access process. Other suggestions for improvements included providing collaborative opportunities between participants at various sites such as phone conferences for site coordinators to exchange ideas and having all CQL students present their research at one site. Mentors at both sites indicated that it would be helpful to provide housing assistance to apprentices.

In sum, the Actionable Program Evaluation findings for FY17 indicate that CQL was successful in engaging apprentices in authentic STEM experiences. Apprentices were actively engaged in learning about STEM and in STEM practices through authentic work experiences to a larger extent than they would typically experience in school. Mentors employed strategies associated with all areas of effective mentoring. Overall, apprentices and mentors had high levels of satisfaction with their CQL experiences, although several areas of potential improvement were noted. In-processing and computer access procedures were a particular focus of suggestions for program improvement

7 | Outcomes Evaluation

The evaluation of CQL included measurement of several outcomes relating to AEOP and program objectives, including impacts on apprentices' STEM knowledge and skills, STEM identity and confidence, interest in and intent for future STEM engagement, attitudes toward research, and knowledge of and interest in participating in additional AEOP opportunities.[8] STEM competencies include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. These competencies are important not only for those engaging in STEM enterprises, but also for all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The evaluation of CQL included students' self-reported gains in STEM competencies and engagement in opportunities intended to develop skills such as collaboration, teamwork, and communication that are considered to be critical STEM skills in the 21st century.

STEM Knowledge and Skills

A large majority of apprentices reported gains in their STEM knowledge as a result of participating in CQL, with more than 80% indicating some gains or large gains in each area of STEM knowledge (Table 36). For example, 90% of apprentices reported at least some gain in their in-depth knowledge of STEM topics and 91% in knowledge of research conducted in STEM fields. Apprentices' reports of CQL's impact on their STEM Knowledge was shared by their mentors who reported similarly on a parallel item on the mentor questionnaire.

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[8] The outcomes measured in the evaluation study were informed by the following documents:

Committee on STEM Education. (2013*). Federal Science, Technology, Engineering, and Mathematics (STEM) education 5-year strategic plan: A report from the Committee on STEM Education, National Science and Technology Council.* Washington, DC: The White House, Office of Science and Technology Policy.

National Research Council. (2009). Learning Science in Informal Environments: People, Places, and Pursuits. Committee on Learning Science in Informal Environments. Philip Bell, Bruce Lewenstein, Andrew W. Shouse, and Michael A. Feder, Editors. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

President's Council of Advisors on Science and Technology (P-CAST). (February 2012). *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.* Executive Office of the President.

Report of the Academic Competitiveness Council (ACC). (2007). U.S. Department of Education. Available on the Department's Web site at: http://www.ed.gov/about/inits/ed/competitiveness/acc-mathscience/index.html.

Table 36. Student Report of Impacts on STEM Knowledge (n=107)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	1.9%	8.4%	25.2%	64.5%	
	2	9	27	69	**107**
Knowledge of research conducted in a STEM topic or field	2.8%	6.5%	25.2%	65.4%	
	3	7	27	70	**107**
Knowledge of research processes, ethics, and rules for conduct in STEM	4.7%	11.2%	30.8%	53.3%	
	5	12	33	57	**107**
Knowledge of how scientists and engineers work on real problems in STEM	2.8%	10.3%	21.5%	65.4%	
	3	11	23	70	**107**
Knowledge of what everyday research work is like in STEM	1.9%	8.4%	22.4%	67.3%	
	2	9	24	72	**107**

Impacts on STEM Knowledge items were combined into a composite variable[9] to test for differential impacts across subgroups of apprentices. No significant differences existed by gender or racial/ethnic groups; in other words, these subgroups of apprentices reported similar impacts on their STEM knowledge.

Apprentices were also asked about CQL's impacts on their STEM competencies (Table 37). Three-quarters or more of the responding apprentices reported at least some gains on all items presented in this section. For example, a large majority of apprentices reported some gains or large gains in areas such as communicating about their experiments and explanations in different ways (92%), supporting an explanation with relevant STEM knowledge (84%), and considering different interpretations of data when deciding how the data answer a question (83%). STEM Competency items were combined into a composite variable[10] to test for differential impacts by gender and race/ethnicity. No significant differences in STEM Competencies were found by subgroup.

[9] The Cronbach's alpha reliability for these 5 items was 0.918.
[10] The Cronbach's alpha reliability for these 10 items was 0.933.

Table 37. Apprentices Reporting Gains in Their STEM Competencies (n=107)

	No gain	A little gain	Some gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	6.5%	17.8%	38.3%	37.4%	
	7	19	41	40	**107**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	4.7%	18.7%	37.4%	39.3%	
	5	20	40	42	**107**
Considering different interpretations of data when deciding how the data answer a question	5.6%	11.2%	35.5%	47.7%	
	6	12	38	51	**107**
Supporting an explanation for an observation with data from experiments	5.6%	12.1%	33.6%	48.6%	
	6	13	36	52	**107**
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	4.7%	11.2%	35.5%	48.6%	
	5	12	38	52	**107**
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	6.5%	14.0%	32.7%	46.7%	
	7	15	35	50	**107**
Defending an argument that conveys how an explanation best describes an observation	12.1%	13.1%	40.2%	34.6%	
	13	14	43	37	**107**
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	4.7%	16.8%	37.4%	41.1%	
	5	18	40	44	**107**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	5.6%	13.1%	42.1%	39.3%	
	6	14	45	42	**107**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	0.0%	8.4%	31.8%	59.8%	
	0	9	34	64	**107**

Apprentices were asked to report on CQL's impact on their "21st Century Skills" – skills such as problem solving and communication that are necessary across a wide variety of fields (Table 38).

Apprentices reported impressive 21st Century Skills gains as a result of participating in CQL, with more than 85% reporting that participation in CQL was responsible for some gains or large gains on each item. For example, over 90% of apprentices reported some gains or large gains in making changes when things do not go as planned (94%) and communicating effectively with others (92%). Items from the 21st Century Skills section of the survey were combined into a composite variable[11] to test for differential impacts by subgroup. No significant differences were found by gender or race/ethnicity.

Table 38. Apprentice Report of Impacts on 21st Century Skills (n=107)

	No gain	A little gain	Some gain	Large gain	Response Total
Learning to work independently	2.8%	10.3%	26.2%	60.7%	
	3	11	28	65	**107**
Setting goals and reflecting on performance	0.9%	13.1%	34.6%	51.4%	
	1	14	37	55	**107**
Sticking with a task until it is finished	0.9%	11.2%	28.0%	59.8%	
	1	12	30	64	**107**
Making changes when things do not go as planned	0.0%	6.5%	23.4%	70.1%	
	0	7	25	75	**107**
Working well with people from all backgrounds	2.8%	9.3%	27.1%	60.7%	
	3	10	29	65	**107**
Including others' perspectives when making decisions	0.9%	11.2%	27.1%	60.7%	
	1	12	29	65	**107**
Communicating effectively with others	1.9%	6.5%	27.1%	64.5%	
	2	7	29	69	**107**
Viewing failure as an opportunity to learn	1.9%	10.3%	30.8%	57.0%	
	2	11	33	61	**107**

[11] The Cronbach's alpha reliability for these 8 items was 0.911.

STEM Identity and Confidence

Since STEM identity, or seeing oneself as capable of succeeding in STEM, has been linked to future interest and participation in STEM as a field of study and career choice,[12] CQL and other programs in the AEOP portfolio emphasize supporting participants' STEM identities. Because of this, the apprentice survey included a series of items intended to measure the impact of CQL on apprentices' STEM identities (Table 39). More than three-quarters of apprentices reported some gains or large gains on all items associated with STEM identity. For example, large majorities of apprentices reported at least some gain in their desire to build relationships with mentors who work in STEM (90%) and feeling prepared for more challenging STEM activities (88%). A STEM Identity composite was created from these items.[13] No significant differences were found in STEM Identity by gender or race/ethnicity.

Table 39. Apprentice Report of Impacts on STEM Identity (n=107)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	6.5%	15.0%	31.8%	46.7%	
	7	16	34	50	**107**
Deciding on a path to pursue a STEM career	6.5%	15.9%	30.8%	46.7%	
	7	17	33	50	**107**
Sense of accomplishing something in STEM	2.8%	11.2%	21.5%	64.5%	
	3	12	23	69	**107**
Feeling prepared for more challenging STEM activities	1.9%	10.3%	22.4%	65.4%	
	2	11	24	70	**107**
Confidence to try out new ideas or procedures on my own in a STEM	4.7%	10.3%	24.3%	60.7%	
	5	11	26	65	**107**
Patience for the slow pace of STEM research	5.6%	12.1%	31.8%	50.5%	
	6	13	34	54	**107**
Desire to build relationships with mentors who work in STEM	0.9%	9.3%	17.8%	72.0%	
	1	10	19	77	**107**
Connecting a STEM topic or field to my personal values	3.7%	18.7%	20.6%	57.0%	
	4	20	22	61	**107**

Interest and Future Engagement in STEM

[12] Chang, M. J., Sharkness, J., Hurtado, S. and Newman, C. B. (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. J. Res. Sci. Teach., 51: 555–580.
[13] Cronbach's alpha for the 8 STEM Identity items was 0.918.

Another key goal of the AEOP is to develop a STEM-literate citizenry. It is important, therefore, that participants be engaged in and out of school with high quality STEM activities. In order to examine the impact of CQL on apprentices' interest in future engagement in STEM, the questionnaire asked them to reflect on whether the likelihood of their engaging in STEM activities outside of typical school activities changed as a result of their CQL experience (Table 40). Approximately 50% or more of apprentices indicated they were more likely or much more likely to engage in all STEM activities after CQL. For example, about three-quarter of apprentices indicated being more likely or much more likely to engage in working on STEM projects in a university setting (77%) and mentoring or teaching other students about STEM (73%).

Table 40. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=107)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.9%	0.0%	45.8%	37.4%	15.9%	
	1	0	49	40	17	**107**
Tinker (play) with a mechanical or electrical device	0.9%	4.7%	46.7%	31.8%	15.9%	
	1	5	50	34	17	**107**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	51.4%	33.6%	15.0%	
	0	0	55	36	16	**107**
Use a computer to design or program something	0.9%	1.9%	39.3%	29.0%	29.0%	
	1	2	42	31	31	**107**
Talk with friends or family about STEM	0.0%	0.9%	26.2%	43.0%	29.9%	
	0	1	28	46	32	**107**
Mentor or teach other students about STEM	0.0%	0.0%	32.7%	38.3%	29.0%	
	0	0	35	41	31	**107**
Help with a community service project related to STEM	0.0%	1.9%	38.3%	40.2%	19.6%	
	0	2	41	43	21	**107**
Participate in a STEM camp, club, or competition	0.9%	0.0%	49.5%	31.8%	17.8%	
	1	0	53	34	19	**107**
Take an elective (not required) STEM class	0.0%	0.9%	39.3%	29.9%	29.9%	
	0	1	42	32	32	**107**
Work on a STEM project or experiment in a university or professional setting	0.9%	0.0%	22.4%	36.4%	40.2%	
	1	0	24	39	43	**107**

A composite score was created from the STEM Engagement items.[14] Subgroup comparisons on the composite revealed no significant differences by gender or race/ethnicity.

Apprentices were also asked how interested they were in participating in AEOPs in the future (Table 41). Approximately three-quarters of apprentices (74%) indicated being at least somewhat interested in participating in CQL again, 60% in the SMART scholarship, 48% in the NDSEG fellowship, and 28% in the GEMS Near Peer Mentor program. Nearly a third or more of apprentices had never heard of the NDSEG fellowship (38%), URAP (29%) and the GEMS Near Peer Mentor Program (41%).

Table 41. Student Interest in Future AEOP Programs (n=107)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	3.7%	10.3%	12.1%	20.6%	53.3%	
	4	11	13	22	57	**107**
Undergraduate Research Apprenticeship Program (URAP)	29.0%	16.8%	9.3%	25.2%	19.6%	
	31	18	10	27	21	**107**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	19.6%	6.5%	14.0%	15.9%	43.9%	
	21	7	15	17	47	**107**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	38.3%	6.5%	7.5%	21.5%	26.2%	
	41	7	8	23	28	**107**
GEMS Near Peer Mentor Program	41.1%	18.7%	12.1%	13.1%	15.0%	
	44	20	13	14	16	**107**

In order to understand what resources are most useful in informing participants about AEOPs, apprentices were asked which resources impacted their awareness of the various AEOPs (Table 42). Two sources stood out as being particularly impactful (somewhat or very much) on apprentices: participation in CQL (81%) and CQL mentors (73%). Approximately two-thirds or more of responding apprentices had not experienced AEOP resources such as AEOP on social media (72%) and the AEOP brochure (65%).

[14] Cronbach's alpha for the 10 Future STEM Engagement items was 0.872.

Table 42. Impact of Resources on Student Awareness of AEOPs (n=107)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	24.3%	13.1%	25.2%	24.3%	13.1%	
	26	14	27	26	14	**107**
AEOP on Facebook, Twitter or other social media	72.0%	22.4%	1.9%	2.8%	0.9%	
	77	24	2	3	1	**107**
AEOP brochure	65.4%	19.6%	7.5%	3.7%	3.7%	
	70	21	8	4	4	**107**
My Apprenticeship Mentor	5.6%	4.7%	16.8%	20.6%	52.3%	
	6	5	18	22	56	**107**
Presentations or information shared through the Apprenticeship Program	25.2%	9.3%	27.1%	19.6%	18.7%	
	27	10	29	21	20	**107**
Participation in the Apprenticeship Program	0.9%	3.7%	14.0%	21.5%	59.8%	
	1	4	15	23	64	**107**

Attitudes toward Research

AEOP apprentices' attitudes about the importance of DoD research are considered an important prerequisite to their continued interest in the field and their potential involvement in DoD or STEM careers in the future. Apprentices were therefore asked to respond to questionnaire items gauging their opinions about DoD researchers and research (Table 43). Apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing to all statements. For example, 95% agreed or strongly agreed that DoD research is valuable to society and 94% agreed or strongly agreed that DoD researchers advance science and engineering fields.

Table 43. Student Opinions about DoD Researchers and Research (n=107)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	5.6%	31.8%	62.6%	
	0	0	6	34	67	**107**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	6.5%	29.0%	64.5%	
	0	0	7	31	69	**107**
DoD researchers solve real-world problems	0.0%	0.9%	4.7%	27.1%	67.3%	
	0	1	5	29	72	**107**
DoD research is valuable to society	0.0%	0.0%	4.7%	28.0%	67.3%	
	0	0	5	30	72	**107**

Education and Career Aspirations

The questionnaire also included and item to gauge apprentices' educational aspirations (Table 44). When asked about how far they wanted to go in formal education after participating in CQL, all responding apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (38%) or terminal degree (44%) in their field.

Table 44. Apprentice Education Aspirations After CQL (n=107)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0.00 %	0
Go to college for a little while	0.00 %	0
Finish college (get a Bachelor's degree)	12.15 %	13
Get more education after college	5.61 %	6
Get a master's degree	38.32 %	41
Get a Ph.D.	32.71 %	35
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	9.35 %	10
Get a combined M.D. / Ph.D.	0.93 %	1
Get another professional degree (law, business, etc.)	0.93 %	1

Overall Impact

The final section of the questionnaire asked CQL apprentices to report on CQL's overall impact on them. Approximately two-thirds or more agreed that CQL contributed in some way to each impact listed in this section (Table 45). For example, apprentices reported that CQL contributed to them having a greater appreciation about the Army or DoD research (93%); more awareness of Army or DoD research and careers (92%); increased confidence in their STEM knowledge, skills, and abilities (90%); and increased interest in participating in AEOPs in the future (80%). These items were combined into a composite variable[18] to test for differences among subgroups of apprentices; no significant differences were found by gender or race/ethnicity.

In order to further understand the impact of CQL on apprentices, an open-ended item on the questionnaire asked apprentices to list the three most important ways they benefited from CQL. The 106 apprentices who provided a response to this item identified various features of CQL that they found beneficial. The most frequently mentioned benefits were the lab experience and opportunity for hands-on, real work experiences (mentioned in 39 comments), the opportunity to acquire research skills (mentioned in 39 comments), the opportunity to network (mentioned in 37 comments), gaining career information (mentioned in 32 responses), and the opportunity to develop specific STEM skills (mentioned in 26 comments). Many apprentices also valued the opportunity to develop various workplace and communication skills (mentioned in 50 comments), including problem solving, critical thinking, time management, confidence, and inter-personal communication skills.

Apprentices participating in focus groups emphasized the value of the laboratory experience in their comments. As one apprentice said, "it's a once in a lifetime opportunity."

[18] The Cronbach's alpha reliability for these 10 items was 0.859.

Table 45. Apprentice Opinions of CQL Impacts (n=107)

	Disagree - This did not happen	Disagree - This happened but not because of CQL	Agree - CQL contributed	Agree - CQL was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	3.7%	6.5%	48.6%	41.1%	
	4	7	52	44	107
I am more interested in participating in STEM activities outside of school requirements	0.9%	20.6%	53.3%	25.2%	
	1	22	57	27	107
I am more aware of other AEOPs	17.8%	5.6%	44.9%	31.8%	
	19	6	48	34	107
I am more interested in participating in other AEOPs	13.1%	7.5%	43.9%	35.5%	
	14	8	47	38	107
I am more interested in taking STEM classes in school	7.5%	27.1%	50.5%	15.0%	
	8	29	54	16	107
I am more interested in earning a STEM degree	4.7%	32.7%	40.2%	22.4%	
	5	35	43	24	107
I am more interested in pursuing a career in STEM	3.7%	27.1%	44.9%	24.3%	
	4	29	48	26	107
I am more aware of Army or DoD STEM research and careers	2.8%	5.6%	33.6%	57.9%	
	3	6	36	62	107
I have a greater appreciation of Army or DoD STEM research	0.9%	5.6%	33.6%	59.8%	
	1	6	36	64	107
I am more interested in pursuing a STEM career with the Army or DoD	6.5%	6.5%	35.5%	51.4%	
	7	7	38	55	107

8 | Findings and Recommendations

Summary of Findings

The FY17 evaluation of CQL collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP's and CQL's objectives and intended outcomes. A summary of findings is provided in Table 46.

Table 46. 2017 CQL Evaluation Findings	
Participant Profiles	
CQL enrollment declined slightly in FY17; participation by females increased while participation from underserved racial/ethnic groups declined slightly.	Overall enrollment for CQL decreased by 3% in FY17 (229 participants), falling short of the program goal of 246 participants, although 17% more individuals applied to the program (565), exceeding the program goal of 517 applicants. as well as number of overall applications by 8%.
	The proportion of female participants —a population that is historically underrepresented in engineering fields – increased to 54% in FY17 (compared to 46% in FY16).
	CQL continued to serve students from historically underrepresented and underserved race/ethnicity groups, however the majority of enrolled apprentices (81%) identified themselves as "White" or "Asian" (85% in FY16). The percentage of Black or African American decreased to 7% in FY17 (11% in FY16) although the percentage of Hispanic or Latino participants increased slightly to 5% (3% in FY16). Only about 12% of enrolled participants identified themselves as being from underrepresented or underserved racial or ethnic groups (13% in FY16), indicating that growing the diversity of CQL participants is an area for continued investment. Over a fifth of participants (22%), however, fell into the category of "underserved" using the AEOP definition of underserved students.[8]

[8] AEOP's definition of underserved includes at least two of the following: low-income students; students belonging to race and ethnic minorities that are historically underrepresented in STEM; students with disabilities; students with English as a second language; first-generation college students; students in rural, frontier, or other Federal targeted outreach schools; females in certain STEM field.

Most CQL participants had not previously participated in other AEOPs and many had not heard of other AEOPs for which they may be eligible suggesting that strengthening the pipeline of AEOPs is an area with potential for growth.	Nearly two-thirds of apprentices (65%) reported having never participated in AEOPs in the past. Apprentices who had participated in AEOPs were most likely to have participated in CQL (15%), SEAP (13%), and GEMS (9%). This represents a decline in previous AEOP participation compared to FY16 when 32% had previously participated in CQL, 14% in SEAP, and 19% in GEMS and fell short of the program goal of 35% of participants being GEMS or SEAP alumni.
	Nearly a third or more of apprentices had never heard of the NDSEG fellowship (38%), URAP (29%) and the GEMS Near Peer Mentor Program (41%), and 20% had not heard of the SMART Scholarship.
Actionable Program Evaluation	
CQL participants continued to learn about AEOP largely through personal connections.	The most frequently cited sources of information about AEOP for apprentices were someone who works with the DoD (33%), someone who works with the program (28%), and someone who works at the school/university apprentice attends (25%).
	Approximately half (52%) of mentors reported learning about AEOP through someone who works with the DoD. Other sources of information (cited by 16% of participants) included the AEOP website and past participants of the program.
CQL apprentices were motivated to participate in CQL primarily for the learning opportunities presented by the program	Apprentices were motivated to participate in CQL by a variety of factors, however the most frequently cited motivators for participating in CQL related to apprentices' educational interests and learning. More than 80% of apprentices indicated that a desire to learn something new or interesting (91%), interest in STEM (90%), desire to expand laboratory or research skills (89%), learning in ways that are not possible in school (81%), and opportunity to use advanced laboratory technology (80%) motivated them to participate in CQL.
CQL apprentices were engaged in STEM practices more intensely than they are in their typical school experiences	Apprentices reported consistently engaging in STEM practices. The STEM practices apprentices reported being engaged in most frequently (weekly or every day) during CQL were interacting with STEM researchers (94%) and working with a STEM researcher or company on a real-world STEM research project (89%).
	Apprentices' engagement in STEM practices in CQL were significantly more intense than their engagement in the same practices in school (effect size is extremely large with d = 2.61).
Mentors used strategies associated with all areas of effective mentoring	Mentors helped make learning activities relevant to students by using strategies such as becoming familiar with their students' background sand interests (98%) and giving students real-life problems to investigate or solve (91%).
	Mentors supported students as learners by using strategies such as using a variety of teaching and/or mentoring activities to meet the needs of all students (83%) and directing students to other individuals or programs for additional support as needed (80%).
	Mentors supported students' development of collaboration and interpersonal skills by using strategies such as having students listen to the ideas of others with an open mind (96%) and having students work on collaborative activities or projects as members of teams (87%).

	Mentors supported students' engagement in authentic STEM activities by using strategies such as allowing students to work independently to improve their time management skills (100%) and providing students with constructive feedback to improve their STEM competencies (98%).
	Mentors supported students' STEM educational and career pathways by using strategies such as asking students about their educational and career interests (96%) and discussing STEM career opportunities within the DoD or other government agencies (89%).
CQL promoted apprentice awareness of DoD STEM careers; besides simply participating in CQL, mentors and program administrators or site coordinators were the most impactful resources to promote this awareness.	A large majority of apprentices (94%) reported learning about at least one STEM job/career, and most (72%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (92%) reported learning about at least one DoD STEM job/career, although somewhat fewer (66%) reporting learning about 3 or more Army or DoD STEM jobs during CQL.
	Apprentices most frequently (88%) selected their mentors as being somewhat or very much impactful on their awareness of DoD STEM careers. The vast majority of apprentices reported that they either had not experienced AEOP resources such as the AEOP brochure and AEOP on social media or found them not impactful on their awareness of DoD STEM careers.
	The program administrator or site coordinator was perceived to be somewhat or very much useful for exposing students to DoD STEM careers by 46% of responding mentors. Most mentors had not experienced AEOP materials such as AEOP on social media (91%), and the AEOP brochure (85%) as resources for exposing students to DoD STEM careers.
Apprentices' awareness of other AEOPs increased as a result of their CQL participation; besides CQL participation, mentors and program administrators or site coordinators were the most impactful resources to promote this awareness.	Over three-quarters (77%) of apprentices reported that CQL influenced their awareness of AEOPs and 80% reported that participating in CQL resulted in an increased interest in participating in other AEOPs.
	Apprentices indicated that participation in CQL (81%) and their CQL mentors (73%) were at least somewhat impactful on their awareness of other AEOPs. Approximately two-thirds or more of responding apprentices had not experienced AEOP resources such as AEOP on social media (72%) and the AEOP brochure (65%).
	Mentors indicated that participation in CQL (78%) and program administrators or site coordinators (48%) were at least somewhat useful (78%) for exposing students to AEOPs. Most mentors reported they did not experience materials provided by AEOP such as social media (91%), the AEOP brochure (78%), and the AEOP website (61%) as resources for exposing students to AEOPs.
Apprentices and mentors were highly satisfied with their CQL experiences, although in-processing and computer access continue to be areas of concern.	CQL features apprentices reported being most satisfied with included the teaching/mentoring provided during CQL (92%), the physical location of program activities (90%), and the amount of the stipend (89%). Few apprentices expressed dissatisfaction with most CQL program features although 17% of students were not satisfied with administrative tasks such as in-processing and networking and 8% were not satisfied with the timeliness of stipend payments.

	More than two-thirds of apprentices indicated being "very much" satisfied with all elements of their research experience (ranging from 67% - 84%). The vast majority of apprentices reported being at least "somewhat" satisfied with each experience (ranging from 80%-94%).
	The program improvements most frequently mentioned by CQL apprentices related to improvements in in-processing and CAC access followed by improvements to mentor communication with apprentices and improvements to the research experience such as providing more or more diverse work for apprentices and providing workshops or seminars.
	More than half of mentors reported being somewhat or very much satisfied with all program features. For example, 67% of mentors were at least somewhat satisfied with research abstract requirements and 63% with communications with CQL coordinators. Few mentors expressed dissatisfaction with program features although 17% reported being "not at all" satisfied with administrative tasks such as in-processing and network access.
	The program improvements most frequently mentioned by CQL mentors related to improvements in in-processing and CAC access, providing more information to mentors, improving communication with program organizers, providing mentors with more information about AEOP, and increasing the marketing and/or outreach activities for CQL.
Outcomes Evaluation	
CQL apprentices reported substantial gains in their STEM knowledge and competencies.	A large majority of apprentices reported gains in their STEM knowledge as a result of participating in CQL, with more than 80% indicating some gains or large gains in each area. For example, 90% of apprentices reported at least some gain in their in-depth knowledge of STEM topics and 91% in knowledge of research conducted in STEM fields. Apprentices' reports of CQL's impact on their STEM Knowledge was shared by their mentors who reported similarly on a parallel item on the mentor questionnaire.
	Three-quarters or more of apprentices reported at least some gains on all STEM competencies. For example, a large majority of apprentices reported some gains or high gains in areas such as communicating about their experiments and explanations in different ways (92%), supporting an explanation with relevant STEM knowledge (84%), and considering different interpretations of data when deciding how the data answer a question (83%).

CQL apprentices experienced substantial gains in their 21st Century Skills.	Apprentices reported impressive 21st Century Skills gains as a result of participating in CQL. More than 85% reported that participation in CQL was responsible for some gains or large gains on each item associated with 21st Century Skills - skills such as problem solving and communication that are necessary across a wide variety of fields. For example, over 90% of apprentices reported some gains or large gains in making changes when things do not go as planned (94%) and communicating effectively with others (92%).
CQL apprentices aspire to continue their education after earning a Bachelor's degree.	Over three-quarters (82%) of apprentices reported that after participating in CQL they aspired to earn either a master's degree or a terminal degree (Ph.D. or terminal medical degree).
CQL apprentices have positive opinions about DoD researchers and research.	Apprentice's opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing or strongly agreeing to statements such as: "DoD research is valuable to society" (95%) and "DoD researchers advance science and engineering fields" (94%).
CQL participants reported increased interest in engaging in STEM activities in the future.	Approximately 50% or more of apprentices indicated they were more likely or much more likely to engage in all STEM activities after CQL. For example, about three-quarters of apprentices indicated being more likely or much more likely to engage in were working on STEM projects in a university setting (77%) and mentoring or teaching other students about STEM (73%).
CQL participants reported gains in their STEM identities.	More than three-quarters of apprentices reported some gains or large gains on all items associated with STEM identity (seeing oneself as capable of succeeding in STEM). For example, large majorities of apprentices reported at least some gain in their desire to build relationships with mentors who work in STEM (90%) and feeling prepared for more challenging STEM activities (88%).
CQL impacted apprentices' confidence in STEM, their career aspirations, and their awareness of and interest in other AEOPs.	Approximately two-thirds or more agreed that CQL contributed to their increased confidence in STEM, their interest in pursuing STEM in the future, their awareness of and interest in DoD STEM careers, and awareness of and interest in other AEOPs. For example, apprentices reported that CQL contributed to them having a greater appreciation about the Army or DoD research (93%); more awareness of Army or DoD research and careers (92%); increased confidence in their STEM knowledge, skills, and abilities (90%); and increased interest in participating in AEOPs in the future (80%).

Responsiveness to FY16 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

In this report, we will highlight recommendations made in FY16 to programs and summarize efforts and outcomes reflected in the FY17 APR toward these areas.

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

FY16 Finding: CQL should focus on growing the pool of applicants overall as well as for underserved groups. The significant decline in participation this year (60%) indicates that much more effort should go into recruiting potential apprentices – outside of the personal connections that are most frequently reported as the primary means of learning about and participating in CQL. Further, though percentages of underserved groups held steady at 13% in FY16, there should be continued focus on growing the representation of these groups in the CQL program. A suggestion for doing this may be to connect with more HBCUs/MSIs, as well as implementing other new methods to actively recruit students nationwide.

CQL FY17 Efforts and Outcomes: In FY17, AAS contacted 122 HBCU's to request a listing on career sites. Program opportunities were listed on 300 university career sites. Program opportunities were also listed on Internships.com which generated interest from all over the US. CQL student participation for AEOP's underserved population increased by 8% in FY17, which is significant since DoD labs have a unique process when selecting student applicants. DoD lab coordinators, not AAS, review applications. AAS will continue to target more HBCUs/MSIs in close proximity to DoD labs, and provide further guidance to lab coordinators that may assist in student selection process.

FY16 Finding: Personal relationships continue to play a key role in how students are recruited into CQL. In order to broaden and diversify the pool of applicants, the program may wish to revise recruitment and selection practices. In particular, AAS may want to consider how the CQL program is publicized to students. In addition, selection processes that ensure applicants are selected based on their qualifications and aptitudes rather than on their personal connections should be considered. These activities should be undertaken with mindfulness of the program goal of recruiting former AEOP participants into CQL, however. Since it is a goal of the program to recruit SEAP students into CQL, the program may wish to work with the SEAP program to ensure that the pool of applicants is broadened and diversified at that level as well.

CQL FY17 Efforts and Outcomes: In FY17, AAS contacted 122 HBCU's to request a listing on career sites. Program opportunities were listed on 300 university career sites. Program opportunities were also listed on Internships.com which generated interest from all over the US. Although, there was in increase in applications in FY17, due to the lack of mentors and decreased funding at the labs, there was not enough capacity for these students. Despite the challenges, the U2 participation increased by 8% in FY17. Similar to SEAP, selection of CQL applicants is at the discretion of the DoD labs. 53% (or 121) CQL participants indicated that they had no prior AEOP experience, including SEAP. 15% (or 34) CQL participants indicated that they, did in fact, participate in SEAP. While the goal of the program is to recruit SEAP students into

CQL, it appears that a high percentage of students are being selected with no prior AEOP experience. Since this percentage is so high, AAS will work with lab coordinators to determine if mentors are aware of the SEAP to CQL progression. In addition, further review shows that only 10% of the total CQL applicants in FY17 had participated in SEAP. AAS will continue to reach out to past SEAP participants to ensure that they are aware of the CQL program, as well as NDSEG and the SMART Program.

AEOP Priority: Support and empower educators with unique Army research and technology resources

FY16 Finding: Since the number of available mentors places a limit on the number of apprentices the CQL program can accommodate, the program may want to consider what incentives it can provide for mentor participation. Mentors in focus groups suggested increased program outreach to potential mentors, program recognition of mentor efforts, and support in the form of overhead funding for mentors as means to increase the pool of CQL mentors. Other mentor recruitment strategies the program may wish to consider include highlighting potential benefits of apprentice involvement in mentors' projects, publicizing the work of apprentice-mentor teams, publicizing the professional accomplishments of former CQL apprentices, and recognizing mentors who exemplify outstanding mentorship practices.

CQL FY17 Efforts and Outcomes: AAS worked with lab coordinators to confirm the importance of CVENT application/registration. Throughout FY17, as an incentive and to increase mentor awareness and recognition, AAS worked with Metriks to profile CQL mentors. Several Alumni spotlights and blogs highlighted mentors throughout FY17. In addition, AAS provided Metriks with CQL apprentice/mentor teams for interviewing purposes. Mentors were also provided with CQL Certificates of Appreciation which were presented by lab coordinators.

FY16 Finding: In light of the program goal to have SEAP apprentices progress into CQL apprentice positions, the low percentage of CQL apprentices who had participated in SEAP is an area with room for growth. The program may wish to work with the SEAP program to ensure that the pipeline between the two programs is clear to both apprentices and mentors. Apprentice responses indicated that mentors are key resources in learning about other AEOPs and therefore efforts should be made to ensure that mentors are informed about the range of AEOPs and that GEMS and SEAP mentors are equipped with information about CQL. Because of the time constraints mentors face in working with students, however, the program should also consider ways to educate participants about AEOP opportunities that do not rely on mentors. Given the limited use of the AEOP website, print materials, and social media, the program should consider how these materials could be more effectively utilized to provide students with targeted program information.

CQL FY17 Efforts and Outcomes: Extensive marketing efforts were conducted to AEOP alumni, which resulted in more AEOP alumni participation in apprenticeships. AAS successfully assisted the RESET program in recruiting laboratory mentors to work with teachers in that program. AAS also helped to recruit volunteer judges for eCYBERMISSION this past year by reaching out to DoD lab coordinators and university directors. Summer weekly AEOP news items were sent directly to the students regarding other AEOP program information, including the DoD STEM Career Guide. Cross promotion/marketing

with GEMS is imperative to ensure a smooth transition to SEAP, and ultimately CQL. AAS will seek GEMS assistance with promoting SEAP, as a next step into the pipeline. AAS will continue to specifically target previous SEAP participants to ensure that they are aware of CQL. Information regarding NDSEG and the SMART program has also been added to FY18 promotional materials. Additional effort will be made regarding year-round or non-summer CQL students to ensure that they are included in the exchange of information.

AEOP Priority: Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army

FY16 Finding: The administrative difficulties noted in both FY14 and FY15 continued in FY16. While students indicated that their CQL experiences were mostly positive, problems with receiving stipends in a timely fashion and lack of computer access continued to color apprentice experiences. Likewise, some mentors reported considerable frustration with apprentice pay issues and computer access. The AAS should be mindful of these issues and leverage its past experience with administering apprenticeship programs to streamline processes and improve communication with apprentices.

CQL FY17 Efforts and Outcomes: Stipends were issued on time this year. AAS assisted lab coordinators with tracking stipends and funding. In FY17, applications opened earlier, and lab coordinators were encouraged to make selections earlier to allow more time for processing CAC cards and security clearances.

FY16 Finding: The continued decline in response rates for both the student and mentor questionnaires raises questions about the representativeness of the results. The program may want to consider emphasizing the importance of these evaluations with individual program sites and communicating expectations for evaluation activities. In addition, the evaluation instruments may need to be streamlined to reduce the time commitment of respondents.

CQL FY17 Efforts and Outcomes: Weekly emails were sent to lab coordinators, students, and mentors regarding survey completion. AEOP encouraged evaluation completion during calls with lab coordinators. Again, as with SEAP, mentors see little value in the survey because it offers them no feedback for improvements at the lab. The survey is only of value to AEOP. Perhaps the evaluation could be updated to offer relevant input for the lab and mentor which will still be of value to AEOP. Several mentors had previously reported that it would be helpful to receive useful feedback, by lab, to encourage program evaluation participation. In FY17, several outcome points were distributed to university directors, with positive feedback received. Therefore, in FY18, AAS will provide similar outcome data to DoD lab coordinators (for distribution to mentors) to show that mentors are making a difference. To assist in streamlining the evaluation process for students and mentors, following the FY17 APR, AAS sent the assessment team several evaluation updates for FY18.

Recommendations for FY18 Program Improvement/Growth

Evaluation findings indicate that FY17 was a successful year overall for the CQL program, as there continues to be increased interest in CQL, noted by 17% growth in applicants for FY17. Notable successes for the year include high levels of mentor and apprentice satisfaction with program features; evidence of strong apprentice gains in STEM knowledge, skills, and competencies; and apprentice interest in participating in AEOPs in the future. Apprentices and mentors continue to report high levels of satisfaction with mentor-apprentice relationships, and both groups likewise report strong apprentice gains in 21st Century skills. While these successes are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY18 and beyond:

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

1. As recommended in FY17, CQL should continue in FY18 to focus on growing the pool of applicants overall as well as for underserved groups. There were some gains in participation of females (54% compared to 46% in FY16) and Hispanic or Latino apprentices (5% compared to 3% in FY16). However, it is warranted to invest more focus and effort on broadening the participation of ethnic/racial groups including Hispanic or Latinos (beyond 5% overall) and Black or African American (only 7% of FY17 CQL group).

2. As in FY16, personal relationships continued to play a major role in FY17 in how students were recruited into CQL. AAS should continue investments that were started in FY17 to recruit more broadly and also follow up to provide expectations to labs that students outside of those mentors know of are included in program participation in FY18.

AEOP Priority: Support and empower educators with unique Army research and technology resources

CQL should continue to recruit and grow the pool of available mentors to support apprentices. The CQL program goal of one-to-one mentoring provides deep and meaningful experiences for apprentices. However, without growing the number of adults to serve as mentors, the program will continue to have unmet need.

AEOP Priority: Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army

As in FY16, mentor FY17 participation in the CQL evaluation is still below the desirable level (20% of population). Apprentice participation improved in FY17 to 47%. It is recommended that CQL continue to strongly emphasize the importance of both mentor and apprentice participation in the CQL evaluation.